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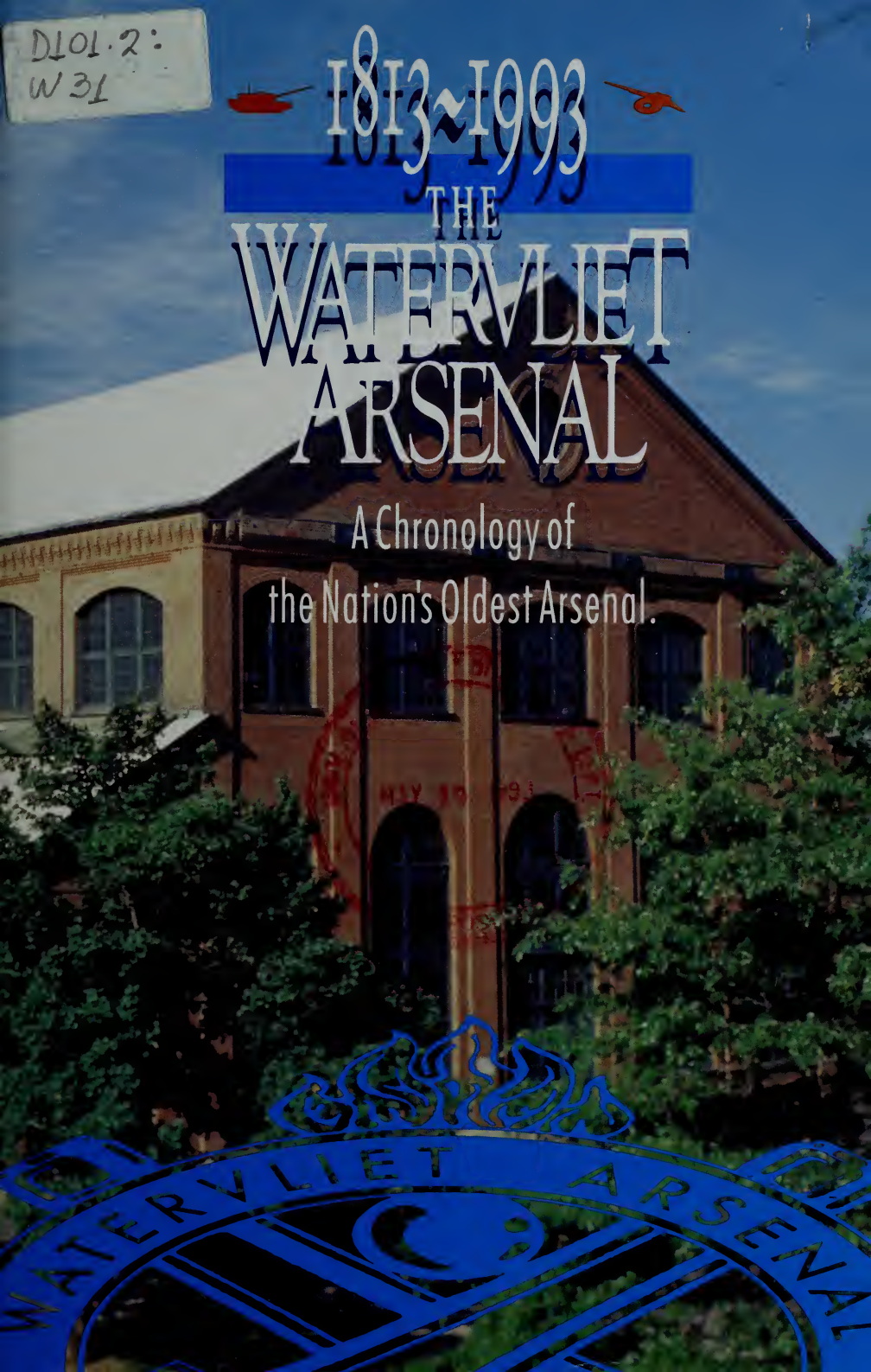
THE WATERVLIET ARSENAL

A Chronology of the Nation's Oldest Arsenal.



1813~1993

THE WATERVLIET ARSENAL

A Chronology of the Nation's Oldest Arsenal.

Edited and compiled
by
James V. Murray
and John Swantek

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"The Watervliet Arsenal: A Chronology of the Nation's Oldest Arsenal" was prepared by the Watervliet Arsenal Public Affairs Office, 1993. This revision incorporates material from several earlier editions and newly-written material updating the arsenal story from 1982 (the year of the last revision) to the present. Copies may be obtained by writing to: Watervliet Arsenal, Public Affairs Office, Watervliet, NY 12189-4050

Preface

Watervliet Arsenal, the nation's oldest, continuously active arsenal, is truly a unique and fascinating facility. Throughout the ebbs and flows of America's history since 1813, Watervliet Arsenal has continued to serve the cause of strength for peace.

This volume is the continuation of a long series of publications dating back to the turn of the century. It has been updated and printed many times. The current edition, however, marks the first time in many decades that all of the type has ben reset and scores of new photographs selected to make this history of Watervliet even more thoroughly enjoyable and enlightening.

Only a relative handful of individuals have their names in this volume. Legions of arsenalites, who have made Watervliet a national asset over 180 years, will never be mentioned in any history written. But they are, in honesty, the real stuff of which arsenal history is made.

I would like to add to the list of those who *are* named: James V. Murray, my co-editor of this edition. For decades, he has quietly contribued to the preservation of arsenal history. His research was instrumental in seeing the arsenal placed on the National Register. He has, on several occasions, written, rewritten and researched updates of this history — without acknowledgment. He remains the singlemost authoritative, encyclopedic resource of arsenal history.

We hope these lessons of the past will show the promise of Watervliet Arsenal's contributions to America's future.

January, 7, 1993

JOHN E. SWANTEK
Public Affairs Officer

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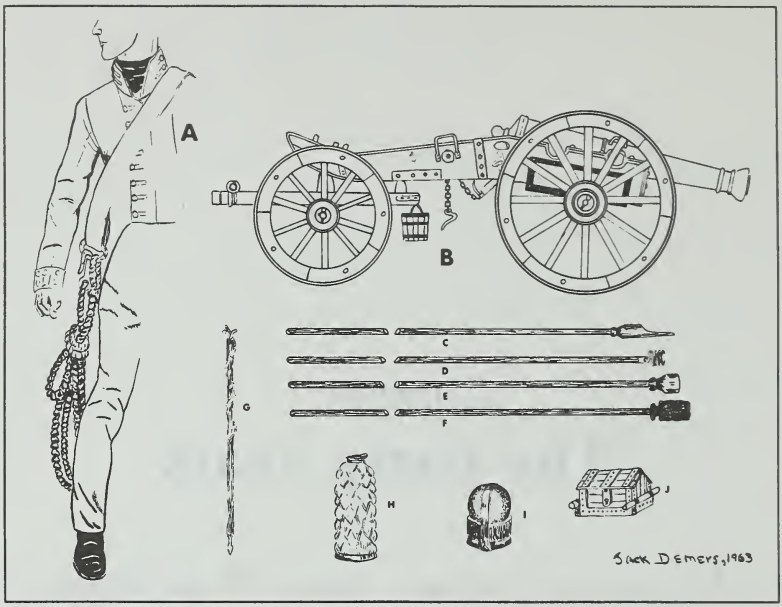
Chapter 1
The Early Years

Uneasy peace filled the years following the successful conclusion of the Revolutionary War. The long struggle among the great powers of Europe for mastery of the continent had created an instability in world affairs which once more threatened to draw the young United States into the vortex. Attempts to keep America from becoming involved had failed and a series of incidents at home and abroad carried America at last to the threshold of war in the twelfth year of the new century. On June 18, 1812, Congress voted for war against England, in accordance with the President's recommendation. He had cited England's impressment of American seamen, violation of United States territorial waters and restraint of American trade. Congress had agreed: the country's only hope for redress of these wrongs lay in a resort to arms. The following day President Madison proclaimed the war, charging England "with a course of conduct insulting to the independence and neutrality of the U.S." Thus, the young nation which once had fought to gain freedom and rights was again at war to preserve them. Yet, England was a most powerful nation



MATERIEL — Early arsenal products included drag ropes, gun carriages, ladles, wormers, rammers, sponges and shot.

with large, veteran armed forces on land and sea, while the United States military establishment was almost nonexistent by comparison. The extent of the American wilderness frontier and seaboard was enormous and the army would have to be much increased to defend it. The task of arming these troops and providing their materiel support over these vast areas was given to the United States Army Ordnance Department, then a little more than one month old.

Decius Wadsworth, Colonel of Ordnance, modestly wrote in November 1812, "The Ordnance Department being a new establishment in this country, and without the aid of experience, it is not surprising that some inconveniences and defects should appear in its organization and some amendments be required in the law which created it." It became evident in later years, as the Department gained in experience that the foundations for its great future had

been firmly and wisely established. Colonel Wadsworth went on to say that the "duties of the Ordnance Department should be limited to providing for and supplying the different armies, forts, posts, magazines, and arsenals of the United States....The responsibility of the Department should cease with the act of delivery from the Arsenal or magazine, and should devolve on the infantry, artillery, or other corps to whom they may be issued....The ordnance and ordnance-stores constitute in time of war a very important item of the national expenditures and should not be wasted with a lavish hand....It would seem better that the supplying of the general posts, forts, and armies should be executed by the Ordnance Department under the general superintendent of the War Department...." With such ideas formulating in his mind, Colonel Wadsworth set out to select the best locations for the Arsenals which must be established.

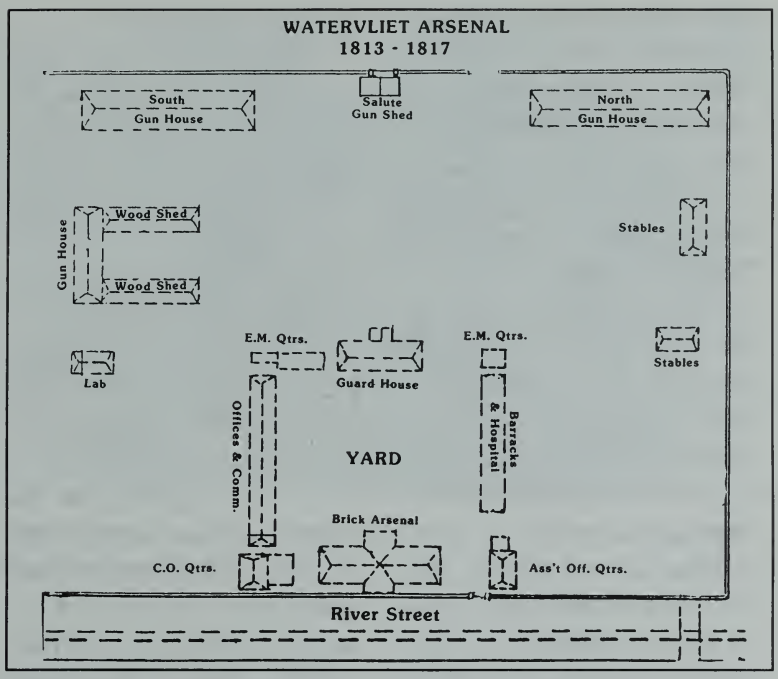
One Arsenal was to be located somewhere in upper New York State, located so that materiel could be sent either north or west with the greatest speed, as the Americans expected to be attacked from the north at Lake Champlain and from the west at Niagara Falls. In the Village of Gibbonsville, which the old Dutch settlers had called "Winter's Plantation," Colonel Wadsworth discovered a very suitable plot. Sharpening his quill pen, he wrote to the Secretary of War that the location was excellent. If the British struck at Lake Champlain, a portage of only 60 miles to the lake from the Hudson River would be necessary. If the enemy came from Lake Ontario, supplies could be shipped up the Mohawk River, and if New York were attacked, the Hudson furnished a means of quick shipment to the south. This was the perfect site. Plans and recommendations surged through the Colonel's mind, and were transferred to paper.

Ordnance began to bombard the War Department with sound blueprints—a network of establishments was

to be set up throughout the United States. The Commissary-General of Ordnance since July 1812, Colonel Wadsworth, proposed an arrangement for "executing the several duties appertaining to his department...." "The principal foundry for casting cannon, mortars, and howitzers will be at Georgetown...The superior quality of the metal and skill of the workmen at that foundry lead to this determination....Pennsylvania has been selected for the principal arsenal of construction for gun-carriages on account of the excellence of the workmanship and materials of carriages generally throughout that state...." And, finally, "The principal establishment for making fixed ammunition and all the small articles of equipment for a train of artillery will be at Albany. The assistant commissary-general will be stationed there, with three or four assistant deputies. The present establishment at New York may be continued on a reduced scale, as subordinate thereto, for the purpose of supplying the seaboard with such articles as a laboratory can most conveniently furnish...." The War Department approved.

Eight months later, on July,14, 1813, a deed was signed by James Gibbons and his wife, conveying to the United States twelve acres of land for the sum of $2,585. This modest purchase, the first of many to come, initiated the history of the Arsenal. The land was ready — the building could start. The Arsenal was on the way toward aiding in the writing of history itself; there was a war being waged at the time and there would be wars in the future. Ordnance, the production of materiel, would be a vital necessity.

The Village of Gibbonsville was a tiny hamlet on the west bank of the Hudson River directly opposite Troy, almost adjoined on the south by the Village of Washington. In the beginning the Arsenal was rather vaguely referred to as being the Arsenal "at Gibbonsville," or "near Troy." Nature herself was to change this, bestowing a name which

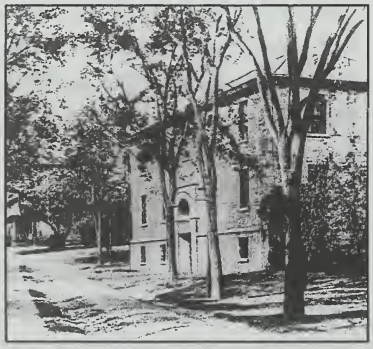


ORIGINAL LAYOUT — The original layout included a guardhouse and barracks for enlisted men.

has become more renowned with the passing years. North of the village, the Mohawk River empties into the Hudson River, frequently flooding the surrounding land in the spring. A word of Dutch origin meaning "flood tide," or "rolling water," became popular in connection with the small area — Watervliet. By the fall of 1817, people spoke of the "Arsenal at Watervliet, N.Y." In the ensuing years, Watervliet and Washington grew together and, by an act of the State of New York, the combination was named West Troy. The Arsenal, however, did not conform. In 1897, West Troy was incorporated as a city, and named Watervliet.

Carpenters, bricklayers, and masons began construction of ten buildings in the summer of 1813. The main buildings were of brick and arranged in a square called the Yard. The largest, a two-

story arsenal, faced the public road. Flanking it were two officers' quarters, and the other structures on the square were used as barracks, hospital, offices, paint shop and commissary. The enclosed "Yard" served as a parade and drill ground. Over a century later, the same plot of ground just north of the Main Gate was bare of buildings and used as an athletic field by Arsenal employees. Workshops and stables were grouped in two places, one southwest of the square, and the other, northwest. They were all wooden structures and were removed about thirty years later, except for two large brick gun houses, one of which was used until 1892.



ARSENALS — Champlain Arsenal at Vergennes, VT.

During the first three years of its existence, the Arsenal was under the temporary command of Captain Thomas L. Campbell. Major James Dalliba, the actual commanding officer, was stationed at Buffalo while the war was in progress. As deputy Commissary of Ordnance he was responsible for supplying Ordnance materiel to the troops fighting on the western and northern borders of New York, and so had under his command the Arsenals and Depots at Buffalo, Batavia, Rome, Watervliet, and later the Champlain Arsenal at Vergennes, Vermont.

Therefore, the many problems arising fell on the shoulders of Captain Campbell. As had been planned by the Commissary-General of Ordnance, work in the shops was done mainly by the enlisted ordnance men, with civilian workers hired by the day, week or month — as they were needed. Standard pay for male laborers was nine dollars per month, with "no allowance of clothing." However it had been

CIRCA 1840 — An artist's rendering of life at Watervliet Arsenal circa 1840.

suggested that children of 12 or 14 years of age, could be employed as usefully as men, and in making empty flannel cartridges women could be economically employed. War is always expensive, and lack of Government funds was a highly serious problem. In January of 1815 the war ended, but in April Captain Campbell wrote to the Chief of Ordnance: "The married men have been much in distress for want of their money during the last winter. I have assisted them to the utmost of my power, any articles they want, and not having the cash to pay it down, the store-keepers at this place have made it a rule to charge at least 20 percent additional for credit." That summer, matters seemed to be no better. The Captain "was under the necessity of procuring a loan from one of our banks to pay the employees for twelve months."

The continual financial struggle was not the only problem during the long months of war. The Captain complained that "the duties of an officer having charge

of a company soldiers between 70 and 80, without any other to assist him, combined with the superintendence of the several branches of mechanics, the completion of the buildings, fabrication of all sorts of field and garrison ammunition and store, with the internal police of the establishment, requires unremitted attention." Combined with this preponderance of substantial hard work was the fact that Captain Dalliba occasionally felt it necessary to remind the temporary commanding officer at Gibbonsville that he was actually in command. In one curt note he made this painfully clear. "Your order to me I do not understand. You will please desist from issuing orders to me on your own authority until you become my superior, respectfully, sir, your obedient servant, James Dalaby." Dalliba changed the spelling of his name several times, and in 1815 was using the form signed to his note.

While Colonel Wadsworth was at Gibbonsville supervising building going on in 1816, Dalliba wrote to ask for some "good and sober men" to help in the construction of the Rome Arsenal. In a terse postscript he added: "Do not suffer Captain Campbell to choose the men, for he will send those he wishes to get rid of and they will be just such as I don't want." Campbell's admirable spirit and industrious nature brought results, although he never did have the satisfaction of actually being placed in command of the arsenal. In August 1816, he was relieved by Brevet Captain David T. Welch, who was also in "temporary command."

In the spring of 1816, Captain Dalliba had become a Major, which seemed to increase his interest in the Arsenal at Gibbonsville. Captain Welch received a letter of detailed instructions from the Major, upon taking over from Captain Campbell. The first and most important topic was finances. Since Major Dalliba himself had not received any army pay in two years and believed that "the paymasters are all dead," he

could appreciate the gravity of the situation. He offered an immediate solution for building an arsenal without government funds: "Purchase materials wanted on credit, by promising payment when the government furnishes you with the means, but don't make yourself personally responsible for the money." He also included some administrative measures: "I would advise that the enlisted men should all be compelled to live on the public ground and, if there is sufficient room, within the Yard. The contrary I think very unmilitary and very improper. I further advise that no canteen or grog shop be kept on the public ground and that no man belonging to the service be concerned in selling liquor of any kind; that no person be allowed to enter the powder magazine without being accompanied by the commanding officer and that every person who enters should pull off his boots and enter in his stocking feet only." It was obvious that Major Dalliba was building foundations for himself to develop, when the time came.

November 14, 1816, Major Dalliba, himself, followed his letter of instructions and assumed command. He gathered up the reins of the Arsenal from the hand of his predecessor in no uncertain manner. His postwar mission completed, he was now ready to settle down and command the Arsenal in person. When hostilities ceased, Dalliba supervised the collection of ordnance supplies and shipped them to Batavia Depot and later to Rome Arsenal. The Rome Arsenal served as an extra warehouse for the Watervliet Arsenal for many years. The captured British arms amounting to about 1100 stands of muskets, were collected by Dalliba and sent to Watervliet Arsenal, where they were sorted and reshipped to New York. He had dissuaded the Government from trying to sell the captured arms at Buffalo, stating that "the people of this Frontier are nearly all supplied with muskets, having found an easier way of obtaining them than by pur-

chase," and it was hoped that they could be sold to "privateers who were fitting for Algiers" at New York. Throughout the year 1815, he advertised regularly in newspapers along the frontier offering rewards for the return of any army property "not in the possession of persons in the service of the United States." The fifty cents offered for the return of a musket or rifle, and the twenty-five cents for pistols, were not attractive enough rewards to bring back many arms to the Ordnance Department.

Military discipline was a prime concern of the new Commanding Officer, who was determined to maintain order. On the very day of his arrival, he issued orders to be read to the soldiers assembled on parade announcing, "The Major is under the necessity of informing the men at this post that, from information long since received, very unfavorable impressions have been made on his mind relative to the conduct and characters of some of them, and that those impressions can be done away with only by his witnessing their good con-

BRICK ARSENAL — A rare photo of the two-story brick arsenal, at left.

duct in future, which he strongly desires."

Men who enlist in the Military Service of any government voluntarily place themselves under the government of Martial Law and the nature of every military service requires that that law should be strictly enforced. The officers appointed by the Government and placed in command are under the necessity of enforcing those laws however unpleasant the task may be in certain cases. The men of this post are informed that the laws and regulations for the government of the Army of the United States and the customs and etiquette of the Army so far as they are applicable to this corps, and all orders will be enforced."

"Those men who conduct well will be treated well and every attention will be paid to their comfort and happiness, but those who conduct badly *shall be punished*, and they are cautioned against trying the experiment."

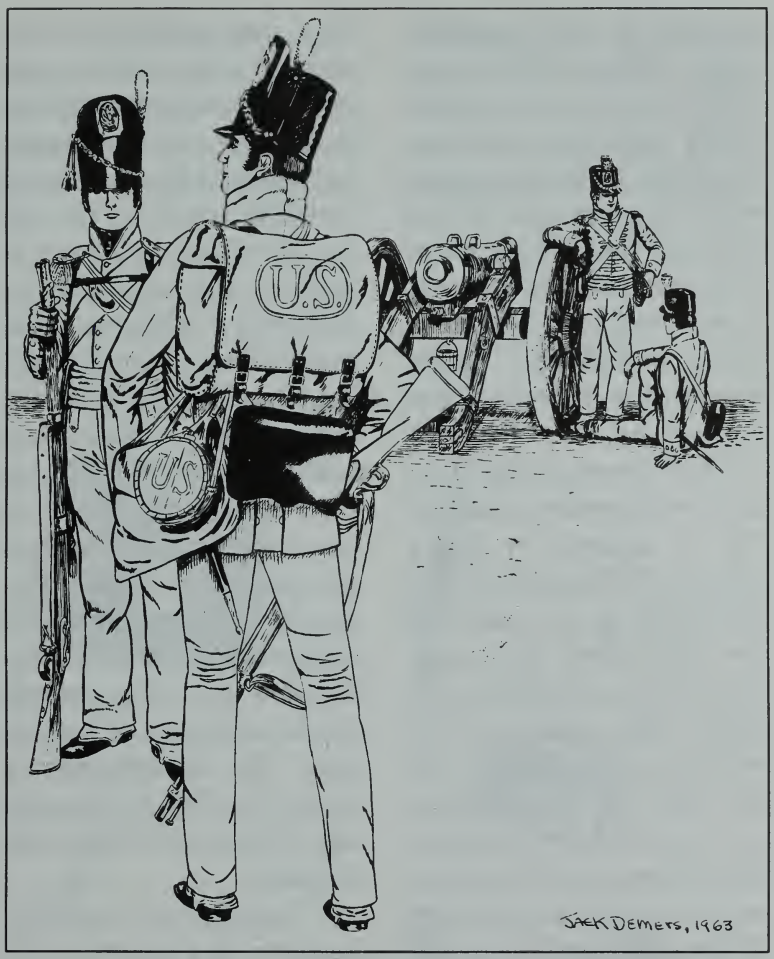
Life at the Arsenal became extremely regimented for the enlisted men. Major Dalliba, in a typical order, proclaimed his idea regarding the basic trouble with the unruly soldiers. "The republican ideas of equality possessed by all Americans before entering the service are totally incompatible with all military government, and by the Army must be abandoned or they will continually lead to insubordination." Personalities must have been submerged in this pattern, with resulting discord from individualists and non-conformists.

The tempo was set by beating drums and shrilling bugles. Orders issued in 1818 and 1819 and in effect for many years, stated "The Reveille will beat one-half hour before sunrise, commencing at the guardhouse, passing through the hall of the barracks, across the Yard, through the back yards of both the officers' quarters and leaving off at the guardhouse. The sentinel at the front gate will be posted at sunrise." During the winter months, the awakening hour was mercifully postponed until daybreak.

After dressing, the men

went immediately to the workshops, built the fires in the blacksmith shop, and laid out the work for the day. Breakfast call was at seven o'clock, after which the men paraded to work. A strict routine was followed the year around, every hour, every day. It was posted that "the Troop will be beaten from the First of April to the First of October at 8 o'clock, and from October to April, when the sun is one hour high. That is always when the men parade for work after breakfast. Roast Beef will be beat at 12 o'clock meridian the year round. The Retreat will be beat the year round at sunset whether there shall be a parade or not, and at no other hour." A bugle was sounded ten minutes before Retreat as a signal for the men to cover the fires in the shops and put the tools away. "Tattoo (call to quarters) will be beat at 9 o'clock P.M. the year round. The warning drum will be beat precisely fifteen minutes before the gates shall be closed and the Tattoo parade formed, as a signal for the men to repair to the Arsenal Yard." Ten o'clock at night men lights out at the Arsenal. Thus ended the day; to these men work must have been relaxation.

Courts martial ran rampant. Officers and enlisted men alike were tried for various reasons, the most common of which was drunkenness. All of the enlisted men were entitled to a daily ration of whiskey which amounted to one-half gill at seven o'clock in the morning, one-half gill at noon, and usually an additional half-gill at night. A gill is one-fourth of a pint, and Major Dalliba, considering the ration sufficient for any soldier, constantly urged and pleaded with them not to drink more. Since they were not permitted to take these rations to their quarters — "it must be drank on parade" — the good Major was undoubtedly correct. As a further enticement, Major Dalliba arranged with the Commissary in 1820 so that any soldier who did not draw his liquor ration would be paid for it instead at the prevailing price of fifty-four cents a gallon. Needless



SOLDIERS OF 1812 — Sergeant and infantry private stand at left while artillerymen relax next to their field piece.

to say, the sign-up list for this offer was not overlong.

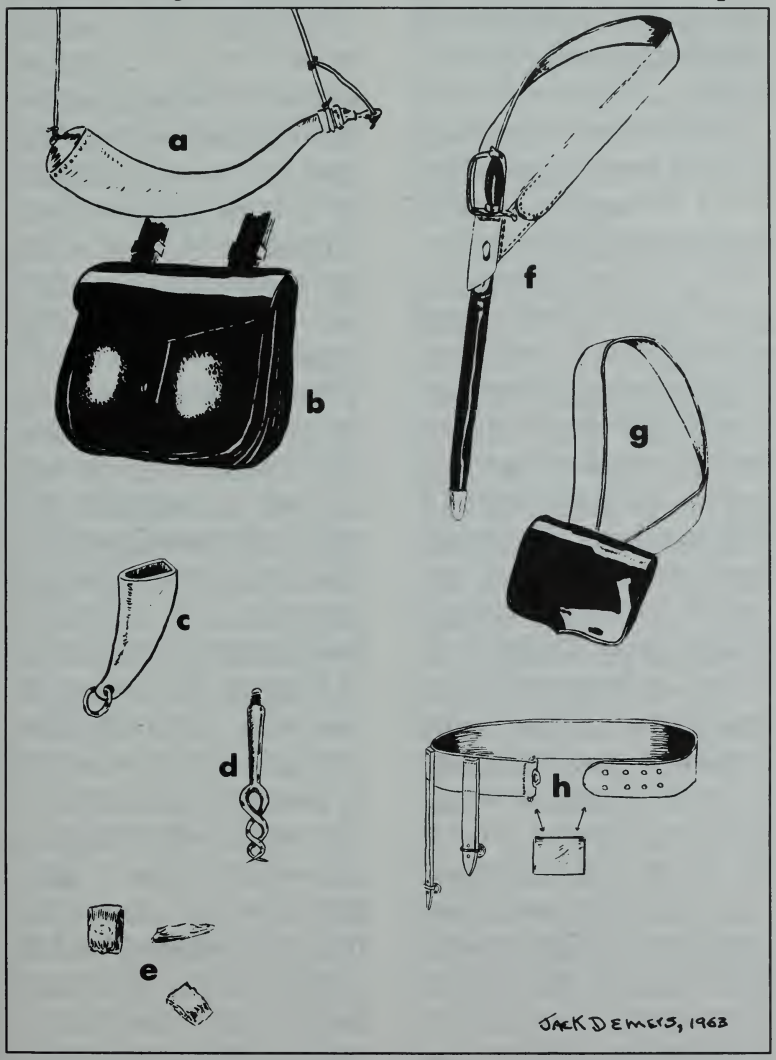
Ordinary intoxication was usually punished with a few weeks' suspension of the army liquor rations and confinement to the Arsenal grounds for the same length of time. However, when intoxication became involved with some other violation of the rules, the punishment increased. One unhappy "Laborer of Ordnance," convicted of disobedience of orders as well as drunkenness,

was sentenced to "be ducked in the Hudson River at the end of the dock. But lest his health might be injured by being put in the water when sober, the execution of the sentence will be deferred until he is found drunk again when it will be put into execution immediately." Oddly enough, the Hudson River loomed up as a frequent method of punishment. Two of the soldiers were sentenced "to be ducked by being thrown off the public wharf three times in succession for two successive days commencing this evening immediately after parade." These sentences, considering the fact that they were in summer and that the men must have known how to swim in order to return to the wharf for the second and third duckings, were really not too severe.

Really serious offenses, such as absent without leave or desertion, were handled more rigorously. Two men found guilty of being absent without leave, and resisting arrest were sentenced to "one month's confinement at hard labor, with a ball and chain attached to the ankle, to be confined at night in the Black Hole, their rations of liquor stopped, and all expenses incurred in searching for and apprehending them, amounting to seven dollars and thirty-seven and a half cents, to be stopped from their first pay." The Black Hole was the damp cellar of the guardhouse. Any soldier who was sentenced to hard labor for a period of time longer than six months was ordered by the War Department "to be transported to the public works and fortifications now being erected on the seaboard of Louisiana." The threat to send a man to New Orleans was usually sufficient to reform his conduct.

"Insolent and mutinous language to a superior officer" was a frequent charge against some of the enlisted men of the post. One soldier who left his duty as "sentinal" and went to the guardhouse to give the sergeant a piece of his mind was tried by a Detachment Court Martial and sentenced to receive "thirty cobbs on his bare pos-

terior in front of parade this evening." A certain "Theophilus Taylor, an artificer of Ordnance, while being detained in the guardhouse for an offense, did say to the Orderly Sergeant when warned of a trial by court martial, 'Damn all your Courts Martial!" The impul-



EQUIPMENT — Arsenal made or supplied: (a) powder horn; (b) bullet pouch; (c) powder measure; (d) bullet worm; (e) flints; (f) sword bandolier; (g) cartridge box; and (h) belt.

sive Theophilus, of course, was given an additional sentence of "fifteen cobbs on his bare posterior in front of parade." However, even the commissioned officers did not submit peacefully to discipline. The actions of one Lt. John Wilson necessitated an order from Major Dalliba, dated November 14,1819, which stated that the officer, "now in arrest, having repeatedly taken the liberty of sending insolent verbal messages by the men to the Commanding Officer, the men are hereby forbidden to carry any verbal messages from Lt. Wilson to him." We can presume that Lt. Wilson proceeded to talk to himself. During Major Dalliba's absence, a rather queer mix-up took place. A soldier, having been imprisoned in the guardhouse by a lieutenant temporarily in command, went to the local civil police and "caused to be issued and served on his Commanding Officer a writ for false imprisonment, on which the Commanding Officer was held to bail for the sum of one thousand dollars." No one but the Major himself, upon his return, could straighten out this matter.

Sunday was a day of rest. It was also a day of several restrictions. The soldiers formed for parade and inspection of clothing and arms at 8:30 in the morning. The men had to attend church, and strict discipline was maintained even while there. The orders read that "Each Sunday when there is public worship in the church in the Village of Washington, every man present on the post who is not on duty, or who is not sick or otherwise disabled, will attend Divine Service both in the forenoon and afternoon. On no account shall the men divide and go to different churches at the same time. They shall choose some one church and attend in one body." One unfortunate soldier left church one hot summer's day to get a drink of water, and was confined to the Arsenal Yard for a month, with a stoppage of his liquor rations for the same period. Obtaining a drink of water was really just about as far as the soldier could go in

the way of exercise and entertainment, since another order commanded that "no drills will take place on Sunday, neither will fishing, playing ball nor gaming be allowed."

Holidays were few and far between; those that did finally appear were not holidays in the real sense of the word. The first mentioned in the orders issued at Watervliet Arsenal occurred on November 22, 1819. "Wednesday being the day appointed by the Governor of the State of New York, in which this post is situated, for a day to be set apart for general Thanksgiving and prayer throughout the State, this garrison owing unto Him equal gratitude, will suspend all ordinary labor and will attend Divine Service at the hour appointed, in uniform. The shops will not be opened." The second "holyday" mentioned, was Christmas of 1819 when "all the men who are neither confined to the Arsenal Yard or public ground and not on guard, will have the afternoon of this day to themselves and may go anywhere within one mile with no passes needed. Those men who belong to the Watervliet Missionary Society will have permission to attend the annual meeting of said society at the Dutch Church without uniform this season." Churches were evidently centers of community activity during this time.

Officers were under more lenient regulations, as evidenced by an episode that occurred on Thanksgiving Day 1819. Major Dalliba, undoutedly with embarrassment, had to write to Washington in 1819 to explain why it had been necessary to shoot one of the horses from the Arsenal team. Two young officers had been loaned the team for a pleasure trip to Waterford, and on the way home had "met with a Dutchman." Naturally, an argument began as to which wagon should go first on the road and, in the ensuing race, the teams tangled. The Arsenal horse fell, breaking a leg, and had to be killed. What Major Dalliba said to the two young officers is not recorded.

Shop work went on at during this time of peace at a steady but unhurried pace, with a variety of jobs performed. Small arms were repaired, oiled, inspected, and stored; gun carriages were repaired or built, timber for which was cut, marked, and placed in the storehouses to season; artillery equipment and infantry accouterments were made and repaired.

Production troubles seemed to be non-existent. If any did exist, they were secondary to the establishment of a smoothly-running post peopled with orderly soldiers. An aristocratic and quick-tempered officer, Major Dalliba nevertheless had the interests of the Arsenal at heart during his eight years in command. Maintenance of military establishments was allotted practically no funds by Congress, and when Dalliba planted trees on the Arsenal grounds, he was reproved sharply by the Finance Department. His reply is a masterpiece of justification: "The authority upon which I purchased the shade trees for this post, was my own judgement. The same authority upon which all my disbursements have been made, and in such case my judgement is law. I am not conscious of having departed from any instructions which I have received. As to the propriety of the purchase and its public utility, no one can doubt. But if the Department wishes to control the detail of purchases, it must issue its regulations before the purchases are made, otherwise it must pass the accounts. No act of mine has been more universally approved at this post than the cultivation of the shade trees. They are its greatest ornament." The elms grew to be stately, symmetrical monuments to his courage in upholding his convictions.

Although schooling for Arsenal children was not compulsory, Major Dalliba was anxious that the thirty children between five and fifteen years of age, who lived at the Arsenal in 1820, attend. The cost of six months of schooling for one child amounted to two dollars, fifty cents of which the State was

willing to pay. The Major had the wood ashes from all over the post collected and sold regularly, the money from which was applied to the school bill. This amounted to approximately fifty cents per child, so that the parents were required to furnish only one dollar for six months of training at the Gibbonsville district school. The scale of pay at the Arsenal, however, made this a prohibitive fee, especially for large families. The pay of the lowest ranking soldiers, termed "laborers," was a mere nine dollars a month, with one ration a day. Master Workmen were the highest paid—thirty dollars a month, with one and one-half rations per day. However, Major Dalliba undoubtedly found some solution for those in need of aid.

The course of the Erie Canal was being laid out in 1821. Permission was granted to dig the canal through the Arsenal grounds, provided the workshops could use the canal water without charge to run some machines. It was always a source of irritation to Major Dalliba that the state had any jurisdiction over the portion of the Canal that passed through the Arsenal; there were many disputes. At the time the canal was dug, he had hoped that the State would change the public road to parallel the "Big Ditch." He suggested that "the dust being raised by travel is now a serious evil to this depot. The buildings are placed so near the road and there is so much travel that in summer we are much annoyed with the dust. The buildings are filled with it and the arms and other property rendered perpetually dirty." This plan was rejected, and the road remained on the bank of the Hudson River. However, it was stipulated that the State of New York should build and keep in repair high tight fences on both sides of the canal where it crossed the Arsenal grounds, and also build a bridge so that the west plot of land would not be isolated.

There were rumors in 1821 that the Arsenal might be closed — the smaller es-

ERIE CANAL — Bldg. 40 stands east of Erie Canal with access bridge at right.

tablishments were being shut down and their arms and ammunition moved to the larger arsenals. In protest, Major Dalliba wrote to the Chief of Ordnance: "I consider it of great importance that the four men now hired be kept in employ at this post through the year since the number to be discharged from the enlisted men is so great. The amount of property now at this post, its value, its present conditions, the importance of its good preservation, all dictate in the strongest terms the necessity of employing more than the eight enlisted men authorized to be kept by your order at this post.... Admitting that our shops must be mostly closed for this year, there is one that I wish at all events to keep open and to keep the business alive, if nothing more. That is the machine shop. Had you a just view of that establishment, its cost, labor, excellent condition and future utility, I am confident you would not permit it to go down, and until I shall re-

ceive particular instructions from you on that point, I shall judge best to keep it in slow operation."

Watervliet Arsenal remained open, but the Ordnance Department proposed in that same year to close the Rome Arsenal and deposit all of its supplies at Watervliet. Major Dalliba succeeded in preventing this move by pointing out that there was not a square foot of storage space at Watervliet, so that new storehouses would be necessary if any added materials were brought in. The cost of transportation by land of the Rome supplies furnished another argument. It was decided to shelve the plan for a few years until the completion of the Erie Canal, as the new waterway was to run through Watervliet Arsenal and to the Rome Arsenal.

Lack of funds became even more serious after this. In April of 1822, the commanding officer wrote plaintively to the Paymaster General of the Army to ask if there was a paymaster for his district. No funds had been received for five months to pay the officers and men, and even the vouchers for postage on business mail, which Dalliba had signed, were rejected by the paymaster. He refused to disburse any more public funds if he did not have the promise that they would be accepted in Washington. He had not received his own monthly salary of $100.20, but that month did receive payment for the preceeding November and December, and in May was paid for January and February. At the same time, Congress ordered, as an economy measure, that artillery companies were to be stationed on arsenal grounds. Confusion and friction resulted at Watervliet. Ordnance officers did need, and expected, the assistance of the artillery men in maintenance and work, since both divisions had been merged in 1821. However, the artillery officers refused, naturally, to take orders from Ordnance officers, with the result that it was necessary to move the artillery companies to other posts.

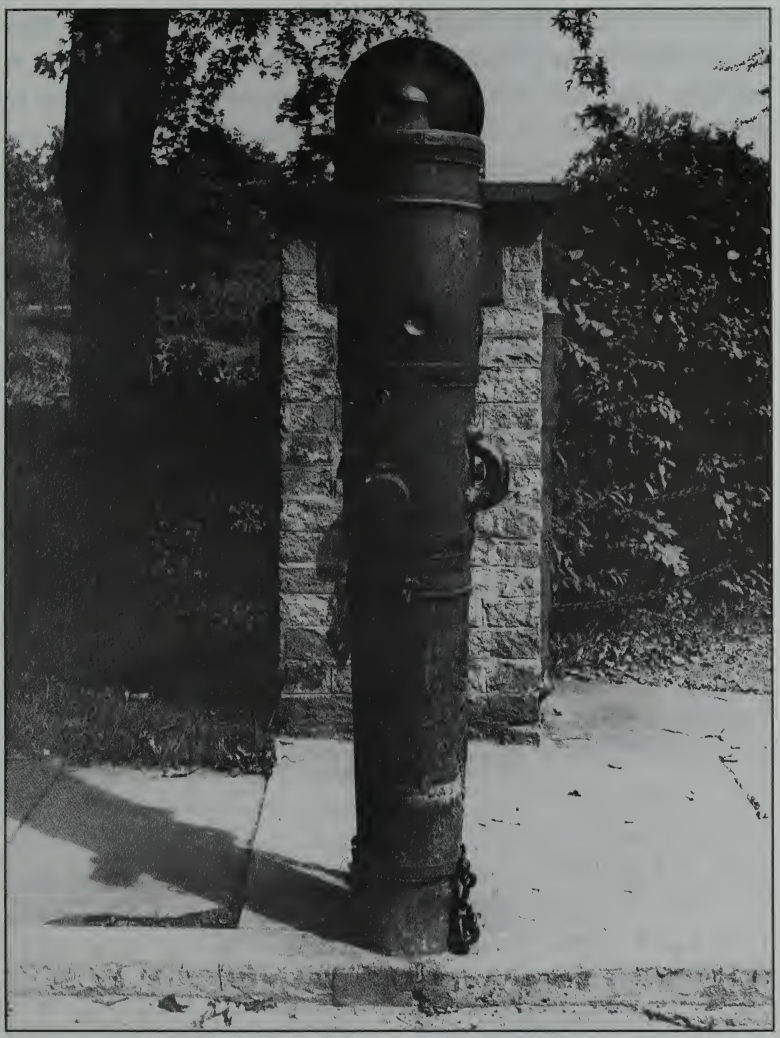
Perhaps Major Dalliba's

choleric disposition was enhanced by the crowded living conditions at the small post. The high-ranking officers were not familiar with Arsenal buildings, but were pertinently informed after they had ordered quarters for four more officers. Another letter found its way to Washington from Watervliet, describing in detail the quarters available, down to the number of steps, the size of the fireplaces, and so forth.

There were only two houses and Major Dalliba explained that "one of these little houses is none too large for any one family. I have occupied and do occupy one of them. I have no room to spare and make my family comfortable, and have a room in which to receive my company. I occupy the smallest for an office, library and cabinet, another to eat and live in, and the other to sleep in with my family. The large room is for my company, the little room for a female relative, one kitchen to cook and the other for my female servant to sleep in. Here is the whole house." A Captain Zantzinger and two subalterns occupied the other little house; the surgeon lived in a rented house with his family, as did one Lt. Lowd, paid for out of their own pockets. He continued, "The office you refer to is a temporary one which I built of about 12 by 14 feet for the accommodation of others, principally. The company clerk does his writing in it; the commissary, his. It contains the books and papers of the post and is neither a fit nor proper place for a commanding officer to do his business."

Congress never did appropriate any funds for new buildings during his command, but Dalliba's plans were carried out by the commanding officers who succeeded him. Two plots of ground were purchased in 1823, changing the shape of the grounds into a rectangle. The half of the rectangle lying west of the canal was later used for the location of officers' quarters. Careful plans for future buildings on this new land had been formulated.

On May 1,1824, Major



LAFAYETTE GUN — Cannon surrendered to Lafayette at Yorktown was used as gatepost. Gun was returned to Yorktown Battlefield restoration.

Dalliba resigned from the Army and was relieved of command of the Watervliet Arsenal. A year earlier he had been court-martialed and had been removed fom his command for two months. His reinstatement to command was not sufficient in his own eyes to remove the

tarnish from his army record; he felt that he must leave the service. For the remaining eight years of his life he was engaged in the development of the iron industry at Port Henry, New York. Undoubtedly he employed his characteristic vigor in this undertaking, and made a success of the venture.

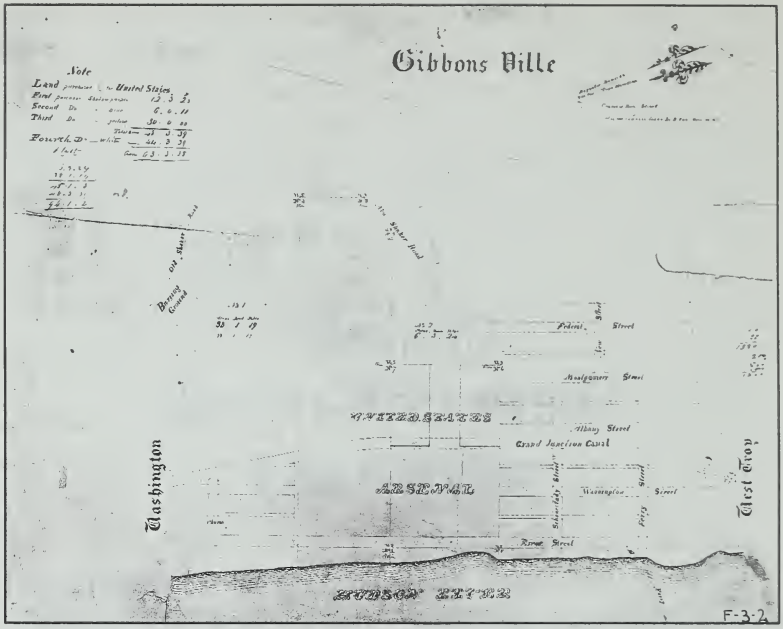
Temporary command of the Arsenal was held for five months by Lieutenant Thomas J. Baird after the departure of Major Dalliba. The highspot of this period was the visit of Lafayette, the French General, who was making a triumphal tour of the United States at that time. He was welcomed by a thirteen-gun salute, inspected the post, and identified a gun as one that was taken by him from Lord Cornwallis when that British officer surrendered to the American Army at Yorktown in 1781. The gun was later incorporated into an ornamental gate on the Arsenal grounds, and was an object of historical interest on the post until it was sent to the reconstructed battlefield at Yorktown in 1938.

Watervliet Arsenal was now firmly established. A little more than a decade in age, it had been through three years of war, and eight years of peace under the able guidance of Major Dalliba. An outstanding personality, his influence was felt at the Arsenal before he arrived and was to be felt in the years following his retirement. The strenuous years from 1813 to 1824 were past; Watervliet Arsenal was ready to expand.

Chapter 2
Years of Growth 1824-1845

The twenty years preceding the Mexican War were filled with innumerable changes at Watervliet: the grounds were enlarged, construction once more began. Three tracts of land were purchased, enlarging the grounds to the size at which they were to remain for one hundred years, and seventeen buildings sprang up on the new land. The general economic depression in the United States, which had resulted in rigid economy and retarded development during the command of Major Dalliba, was lifting. Envisioning a great future for the post, Major Dalliba had written in 1821, "It will be the great central one (Arsenal) for the northern states. Its situation is most advantageous. A great quantity and value of public property will and must of necessity accumulate here, and there must be good room to deposit, to arrange, clean and take care of it."

Major George Talcott, who succeeded Major Dalliba, was no less zealous in his efforts toward expansion. One of the most able ordnance officers of his time, Major Talcott was in command for the first ten years of this period of growth. A sound businessman, he was an excellent administrative



SURVEY — A copy of the survey map of 1826 shows the boundaries of the expanding arsenal.

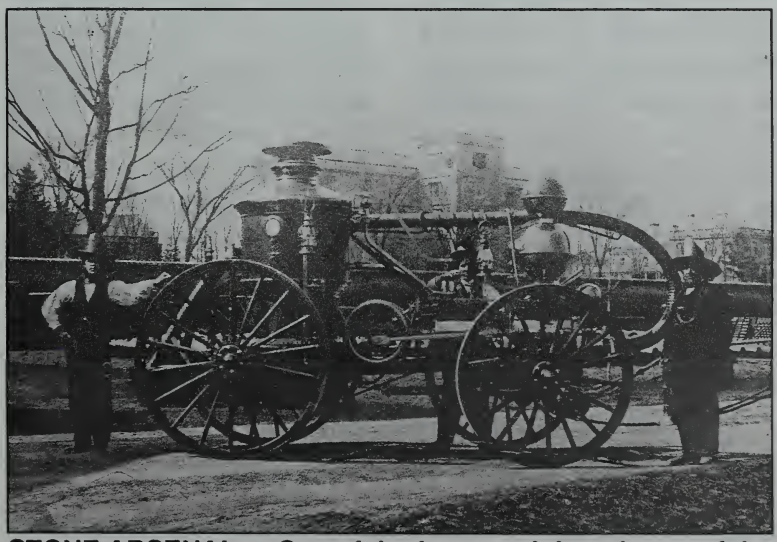
officer. As soon as he assumed command, he began to urge the Ordnance Department to buy land adjacent to Arsenal grounds, as he believed that the price of land would soon advance. He knew that larger grounds would be needed for the future, and at present, powder magazines had to be constructed in an isolated location. Thirty acres of land were purchased in 1828 to the south, and in 1833 the largest single purchase ever made by the Arsenal added two tracts of land totalling forty-five acres. Within a year after his arrival, construction of many new buildings began.

A stone arsenal, which had been planned in detail some years earlier by Major Dalliba, was erected on the west bank of the Canal. The finished two-story structure of limestone, with a tower in the center, was a source of pride to the Arsenal personnel. Its cost — $30,000 —

was considered enormous in 1826, but the building proved its worth and was in constant use until 1889. The floor space in the new arsenal was reserved for the finest guns that arrived directly from Springfield Arsenal; the old French guns were boxed and stored in the basement so that the new guns could be stored in racks. Approximately 140,000 muskets could be stored in boxes, and 100,000 in racks.

Other less pretentious buildings were also completed — lumber sheds, a saw mill, blacksmith shop, nitre storehouse and gun-carriage shop. Two buildings located in the western part of the grounds, were so well made that they were still in use more than 120 years later. One, a stone powder magazine, was separated from all other buildings in event of an explosion; the other, a house for the magazine keeper, was nearby, and in 1944 was used for an officer's quarters.

Under the general heading of protection, Major Talcott supervised several innovations. Fire protection



STONE ARSENAL — One of the few remaining photos of the stone arsenal, visible here behind firefighting apparatus.

was a necessity; the center of the square was turned into a cistern holding 12,000 gallons of water, and the commanding officer shopped carefully for a good forcing pump. Flood protection was the next consideration. Since spring floods caused great damage and inconvenience almost every year by filling the cellars of the buildings in the original square, some sort of levee was necessary. Some years before, a small levee had been built but offered small protection, so that Major Talcott was delighted to learn that a road company was planning to construct a macadam road from Albany to Troy in 1829. A hard-surfaced road along the river would both eliminate the clouds of dust and act as an excellent levee. To aid in the construction, much to Major Talcott's dismay, the Government had to contribute $1,200. However, it was money well spent. The last item was plant protection; $10,000 was set aside in 1829 to build a high stone wall around the entire arsenal grounds.

Unlike Major Dalliba, Major Talcott was not a field commissary with general supervision of other Depots and Arsenals in the northeast portion of the United States, but he was charged with responsibilities other than those of

SECURITY — In 1829, $10,000 was spent to build stone wall around the arsenal grounds for security.

his own busy post. The United States Depot at Vergennes, Vermont, in its founding and operation, was under the general care and supervision of the commanding officer of Watervliet Arsenal. Instructions of June 8, 1826, of the Chief of Ordnance to Major Talcott read that "the general control of the business will consequently be confided with you, and the officer who may be in charge (at Vergennes) .... will receive his instructions from you." In 1824, he had looked after the removal of the military stores from the Arsenal at New York, and in July, 1827, he wrote to the head of the Ordnance Department: "In compliance with your Orders .... I have visited the town of Augusta, in Maine, for the purpose of selecting a site for an Arsenal to be erected there...." The difficulties of travel made necessary rather frequent, and occassionally somewhat long, periods of absence, taking a great deal of the commanding officer's time and effort.

Colonel George Bomford wrote in 1825, relative to Major Talcott's services in the selection of sites for western armories and arsenals, that "It is estimated that the entire period of your service amounts to 437 days, and the distance traveled is 3,454 miles .... " This figure is enormous, considering the methods of travel. For instance, even vacations had their difficulties, as outlined in a letter from Roswell Lee, Springfield Armory, regarding the Talcotts' and Lees' two weeks' vacation in 1827: "My present calculation is to leave here on Monday, the 4th of September and arrive at your place on Tuesday morning on our way to the Springs, and Niagara .... it will be necessary for us to travel with as much dispatch as possible ... not so as to make it a 'toil of pleasure' ... but I wish to return by the 20th. I suppose if we are all in Health, by traveling alternately in the Stage and the passage Boats we can continue our progress every day, remaining about three days at the falls and vicinity and only one day at the springs on our way out." Ten days of

steady traveling resulted in four days of relaxation.

Production at the Arsenal, due to limited space, was much restricted in early years. Materiel comprised chiefly fuses, rockets, percussion caps, sponges, gun carriages, and accessories for the equipment of gun carriages in field service. The list of articles produced was much expanded, with the gradual growth of the post. The storage and preservation of military stores still was important, and presented many difficulties. The care of powder — testing it and keeping it dry — was one of the most serious problems with which the officer in charge had to deal. Dampness and dry rot in the powder magazines presented never-ending difficulties. Major Dalliba had found that to "sift and let it fall some feet through the fresh air once in two or three years ... and keeping open the windows during the dry part of clear days," helped to preserve the powder. Major Talcott also worried about powder storing, and the merits of casks versus barrels. Experimentation characterized these years, and improvements in means and methods of caring for ordnance stores resulted.

The development of production is closely interwoven with the era of the Erie Canal. The post for nearly half a century, depended largely on that waterway for motive power in the operation of its shops. Major Talcott presented the case to Governor Throop and permission was granted in 1830 to use the water from the "Grand Canal" more extensively "to run two pairs of five feet Burr Mill stones." The machinery at the post had hitherto been run by horsepower, but Major Talcott pointed out that "the demands for the arming of the Militia and other purposes require the aid of additional machinery and facilities for performing labor which can be affected by an increase of the horsepower and the employment of a steam engine — the use of a water power, if such can be obtained. The latter is preferred on account of the necessary intermissions and fre-

quent stoppages incident to the nature of the work, which would render a steam power (so valuable for manufacturing purposes generally) ineligible and not convenient. It is proposed to erect a water shop on the plot of ground lately purchased and to use the creek to conduct the water again to the river." He appealed to the governor's financial and practical side, indicating that the measure would not in the least injure the Canal, and would be no expense to the State. Furthermore, since the Arsenal prepared and preserved the means for defense for the State and the arming of its Militia, it seemed that the grant was "so entirely of a public nature and so interesting to the state at large that no objections to the measure can be anticipated." These were not just words — for many years, almost a third of the operating expense of the post was expended for arms for the State militias. In a letter of 1834, speaking of arsenal activities, Major Talcott wrote that "the preparation and preservation of the means of defense at this Depot have for their object the arming of Militia of New York and Vermont (and to) supply the whole chain of lake ports along the northern and northeastern portions, and seacoast defense from the waters of Narragansett Bay to the harbor of New York." The Governor's consent was a cornerstone for this extended activity.

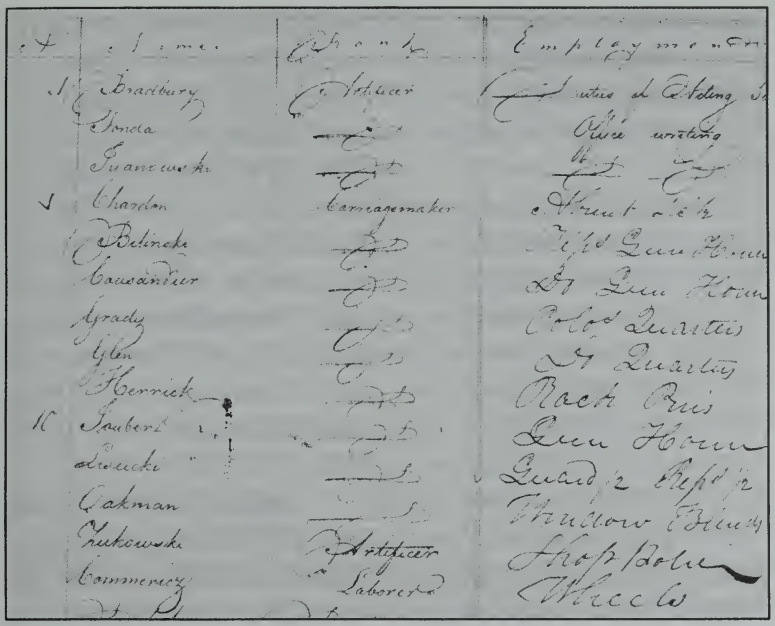
The Ordnance Department was reorganized on an independent footing in 1832 — by the act of March 2, 1821, it had been merged with artillery — and Major Talcott became a Lieutenant Colonel. At the same time, the number of officers and enlisted men assigned to the Arsenal was set at one Captain, one Lieutenant, and 25 enlisted men; however, this was in writing only. No appropriations were made to pay the enlisted men, so that the number had to be cut to eight for the remainder of the year. With increased funds the following year, the situation improved and the Arsenal received enough money to paint the new workshops,

buy some machinery and grade the ground around the new buildings.

Colonel Talcott left the Arsenal in 1835, and in 1848 became Chief of Ordnance. Later that same year he was breveted Brigadier General for his meritorious conduct in prosecuting the War with Mexico. He served in the Army until 1851, and died eleven years later. He left the Arsenal, at the end of its second decade, an active, extensive post—one which would have pleased Major Dalliba in the fulfillment of his ideas.

Lieutenant Colonel William J. Worth, who commanded the Arsenal from 1835 to 1838, was a popular military hero and reputed to be the best horseman and the handsomest man in the Army, "being of a tall and commanding figure." Born at Hudson, NY, of Quaker ancestry, he was well launched on a business career in Albany at the age of eighteen, when the War of 1812 began. He was appointed a First Lieutenant in the infantry, upon applying for a commission, and as aide to General Winfield Scott, Worth served so efficiently that he had attained the rank of Major before the war ended. When the Ordnance Department was reorganized, he transferred, and three years later took command of the Watervliet Arsenal. After three years at the Arsenal, he was appointed a Colonel in the Infantry and served brilliantly in the Mexican War. In 1849, he died of cholera at San Antonio.

One of the first problems to confront Colonel Worth when he arrived at the Arsenal concerned the hours of work, and payment for same, of the civilian workers. By 1835, the number of civilian workers in the shops had increased to 90, while the number of enlisted men had dropped to 45. The workers thought that they should receive additional compensation for working more than eight hours a day, but since they were receiving more than other establishments in the vicinity, Colonel Worth disapproved. Most factories at that time worked 10 hours a day the year around, but, be-



WORK RECORDS — Pages from 1836 work account book show positions and wages to be paid.

cause of the explosives handled at the Arsenal, it was considered too risky to light the shops by candlelight for night work. For this reason, shorter hours were in force during the winter, which lengthened in proportion to the rays of the sun. Some of the laborers protested vigorously at the longer hours necessary to take advantage of the summer daylight, with no advance in their average pay. At the time, Master Workmen made $2.75 a day, blacksmiths and painters $1.50, and unskilled laborers about seventy-five cents. Some six years later, another survey was made of prevailing wages in the vicinity, which revealed that conditions were still better in the Watervliet Arsenal. Wages had increased slightly during that period, and the workmen were paid in accordance with the quality of their products instead of quantity, as was the case in private factories. Since the workmen could

gain nothing at that time by going elsewhere to work, there seems to have been no further dispute over the question.

Little building was done during Colonel Worth's command. The most important amount allotted to the Arsenal for construction was $19,000 for the continuance of stone walls around the Arsenal grounds. More important matters occupied the United States Government, since it was feared for a time that the United States might find itself at war with France. "To meet the exigency of threatened troubles with France," a large number of Fortress gun carriages were turned out, by necessity, of unseasoned timber. The war did not materialize; the carriages were stored and, some years later, demolished, since the green wood had warped and split. The seasoning of lumber for manufacture was one of the production worries that faced the commanding officer.

While Colonel Worth was absent on temporary duty, he appointed Lieutenant W. A. Thornton to temporary command of the Arsenal. The Colonel was destined never to return to Watervliet; he was suddenly ordered to active duty in the battles being waged in Florida against the Seminole Indians. Twenty-three years later, Major W. A. Thornton was in full command of the post during two years the Civil War.

Another veteran of the War of 1812, Major Rufus L. Baker, arrived to take the command of the Arsenal in October 1838, and remained for exactly 13 years. During that time, the War with Mexico was fought and, in recognition of his excellent work during wartime, he was breveted a Lieutenant Colonel in 1848.

"Red tape" existed even in those days, as evidenced by Major Baker's first efforts with regard to reconditioning Arsenal buildings. He found that it was necessary to receive permission from Washington before so much as replacing a broken windowpane. As late as 1847, Major Baker wrote that "....

most of my letters from Washington are now four to six days in coming ...," so that the time wasted was tremendous. The Secretary of War was persuaded to change regulations so that he might make minor repairs, using his own judgment. Plans for a new building program were laid.

The original buildings in the square had reached a stage of unsightly decay in 1838, and the square was too small and crowded to meet the expanding needs of the workshops. Wooden sheds had been added at various places and then left to fall into disrepair. It was decided that the old buildings would be removed, a few at a time, and new ones erected west of the canal. The greatest need was for a new paint shop, two gun carriage houses, and a laboratory for ammunition; all of these were erected while Major Baker was in command. War always results in improvements in government establishments; construction must precede, as well as succeed, destruction in the scheme of events. The war machine must be kept running smoothly.

The tempo of production in the Arsenal workshops increased, with the emphasis upon carriages for large guns. Shipments were made daily from the wharf on the Hudson River and via the Erie Canal. Some munitions went west up the Canal to the "Indian hostilities on the Northern Frontier," while others were loaded on sloops sailing down the river to the soldiers who were fighting the Seminole Indians in Florida. Shipments by land were more difficult, and were restricted mainly to consignments for Maine or Boston; railroads were used part of the way, but wagon trains were generally more economical in 1839. The type and destination of supplies leaving the Arsenal are vividly illustrated in orders issued by Major Baker to a young lieutenant of the post that same year.

"You will accompany the train of artillery that will leave this Arsenal tomorrow morning for Boston. The train will consist of nineteen 6-pounder carriages, with 6-pounder

brass cannon to which will be added twelve 6-pounder cannon at the Springfield Arsenal, and of six 12-pounder howitzers mounted upon carriages, each carriage having its equipments. The nineteen carriages marked 'Maine,' with the eighteen 6-pounder cannon will be delivered to the Adjutant General of Maine at the City of Portland. The six howitzers marked 'U. S.' will be forwarded to the Kennebec Arsenal at Augusta.

"The hand spikes, rammers and sponges, ladles and worms, buckets and prolongs, are upon their traveling positions upon the nineteen carriages for Portland. All the other equipments are contained in boxes, duly marked, and will be forwarded by wagons upon your arrival at Worcester. You will either forward the whole train by railroad to Boston, or by the teams that take them hence, according as you may find the most economical or expeditious. If, when you get to Boston, you find that there is still ice in the Kennebec River, take all the supplies by land by way of Portland."

Major Baker was immensely proud of the arms turned out by the Watervliet Arsenal and was most indignant when he received a report from Sacketts Harbor that "a recent inspection of five companies gives a woeful exhibition of the new National Armory arms, issued from Watervliet in September .... Their work is bad, and the parts of many locks have yielded on fair service." He retaliated sharply: "Officers are apt to receive the reports of non-commissioned officers on those subject who, to cover their own neglects of the delinquencies of their comrades, charge to defective material or workmanship in their arms those failures which nine times out of ten are the result of sheer ignorance in the use of arms." No reply is recorded, although those using the material must have defended themselves.

A major change took place in the shops in 1839, with the introduction of steam engines. The Erie Canal was closed and drained during the

whole of the winters of 1839 and 1840, in order to deepen the canal bed. A dry canal meant idle shops, since all of the large machines were operated by power from water mills, so Major Baker began shopping for a steam engine for alternate power. He sent a request to the Ordnance Department for the purchase of one "with power equal to eighteen horses and costing only $5,000." He was notified that a "practically new engine of eight horsepower" had been put aboard the sloop "Exertion," and would arrive shortly from the Watertown Arsenal where it had not been needed. The loss of the power of ten horses was probably worth the delay that undoubtedly would have accompanied the purchasing of an engine.

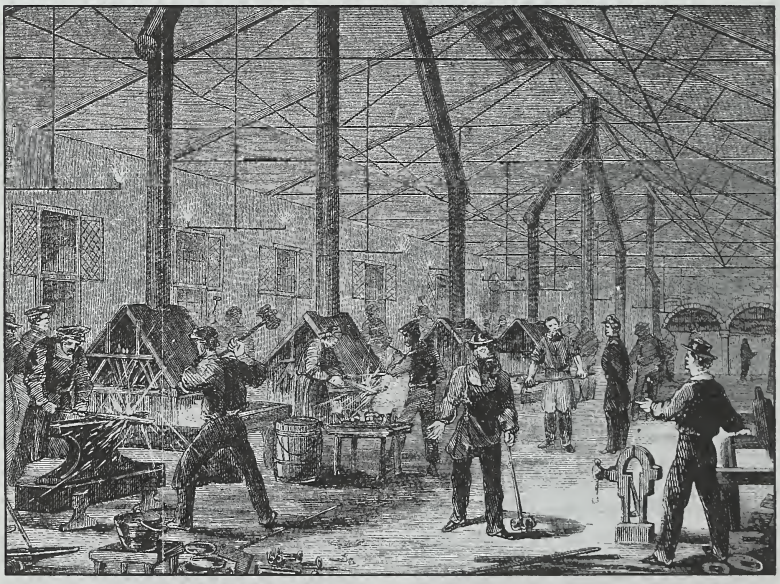
To increase efficiency and lessen confusion in the shops, Major Baker issued a new set of rules. Master Workmen were instructed to deduct from their own paid hours when they were not actually working, just as they did from the pay of ordinary laborers. Workers were forbidden to bring books or newspapers into the shops for reading purposes during working hours. Children were to stay out of the shops unless accompanied by adults who were responsible for their actions—it seems that neighborhood youngsters had been running through the shops collecting shavings and chips. Major Baker also asked the Ordnance Department for $450 for a tower clock, so that arguments about working hours might cease. Another change inaugurated in the shops was the melting of scrap iron for reuse rather than selling it at auction, where the bids were always very low. After being reworked, most of the scrap iron was used in strengthening the gun carriages.

Production received a setback in the spring of 1840, when the big blacksmith shop burned, leaving only the walls standing. Efforts to fight the fire were hampered by a high wind and the fact that the suction hose had become mud-clogged by being thrust too deeply into the cistern. Major Talcott's fire protec-

tion had come to naught. The smithshop was later rebuilt on the same site, and during the Civil War was transformed into a wing of the Broadway Shops.

Alarmed by the fire, the citizens of Troy persuaded their Mayor to protest to Major Baker about the 265,000 pounds of gunpowder stored in the Arsenal magazines. It took all the diplomacy that Baker could muster to soothe the ruffled townspeople. He explained that every precaution was taken at the Arsenal to protect the magazines from an explosion, and if one did occur he doubted whether it could seriously affect the town — the powder magazines were 70 feet above the Hudson River, 40 feet high than the town of Troy, and a half mile down the river. Major Baker concluded whimsically, "However, the Arsenal wanted an explosion even less than Troy did."

As commanding officer of the principal manufacturing Arsenal in the Ordnance



FORGE SHOP — Forging the iron work for gun carriages in rebuilt smithshop.

Department, Major Baker was appointed a member of a board of officers to visit military establishments in Europe and learn the latest methods of manufacturing artillery. In April of 1840, the group departed. At that time, the American Army was patterned after the French so that the officers paid particular attention to the French cannon foundries, arsenals, powder mills and small arms plants. They also toured England, and made exact drawings and reports on all that they saw. The Chief of Ordnance expressed his delight with the cordial reception that the officers of "our small new nation received in magnificent Britain and mighty France." If only he could have seen the role that the "small new nation" was to play 100 years hence.

One of the subjects in which the officers were especially interested was the "mineralizing" of wood for gun carriages. Cast iron carriages had been tried at Watervliet Arsenal and were found to be very breakable, especially in cold weather. As there were no facilities at that time for improving the iron used, they returned to the use of wood, with the hope of toughening and strengthening it in order to prevent decay, by soaking the timber in mineral solutions. It was a grave problem, as wood suitable for gun carriages had grown scarce along the eastern seaboard, and that which was available had to be seasoned for quite some time. The need for more durable carriages had been clearly revealed in the heavy fighting against the Indians along the hot and humid Gulf Coast.

Experiments in mineralizing wood started in 1840 at the Watervliet Arsenal. When Major Baker returned from Europe the next year, he brought new information from his observations in England, and experimentation began in earnest. For four years, pieces of wood were steeped in chemical solutions for varying lengths of time, and at varying temperatures. Large vats were built which attendants watched day and night through the years, in

order to regulate the temperature. Finally, Major Baker reported that he could not detect any benefits whatsoever from the soaking process. Howls of anguish went up from the inventor, a Philadelphia chemist, who demanded that the experiemnts be undertaken for another four years. Major Baker refused, stating with characteristic simplicity that "Facts are stubborn things, and all the theory in the world could not restore to soundness the timber which I have reported as positively decayed."

Major Baker's European journey was further evidenced in the important building program of 1841. His plans for a new paint and harness shop were taken from a building in the Arsenal at Douai, France, and he ordered an iron roof from London for the burned shell of the blacksmith shop. The iron roofs in London had made quite an impression, as they were the only type at that time which were fireproof, and only English factories were manufacturing them. It was now especially important that the blacksmith shop did not catch on fire again, for the ammunition laboratory building had been completed and was in operation not far away. Since the laboratory building, completely modernized, was used in the the Second World War as a recreation building by the Arsenal employees, Major Baker's precautions must have reaped results.

Quarters for the Commanding Officer were completed in 1842. Major Baker chose a style of architecture and materials to harmonize with the stone arsenal which was located just north of his quarters. At the same time, plans for a double quarters to be built on the other side of the stone arsenal were drawn up, but it was not constructed until 1848. These buildings were all massive, square, gray stone structures, facing the canal. The limestone walls were backed with brick, making a thickness of two feet, while the deep-set windows were seven feet high. Baker believed that the "old fashioned pitched roof of the arsenal would look well upon

QUARTERS ONE — New quarters for the commander were completed in 1842.

the quarters, ... adopted a hip roof as being more appropriate." He later found that the "modern" hip roof was not practical in New York State winters, when ice clogged the gutters and melting snow water backed up under the slate shingles. The arsenal which had set the architectural style was demolished in 1889, but the substantial quarters were still in use — Quarters numbers one, six and seven — during World War II.

QUARTERS — Other officers quarters were also built of stone.

A two-story, limestone barracks was erected in 1843, and was in continuous use by

enlisted ordnance soldiers for almost 100 years before it was converted into offices. A stone wharf and river wall were constructed in the same year, since the Hudson River was used for shipments to the south as long as it was not solid with ice. In connection with this, occasionally the Arsenal officers misjudged the navigability of the flowing Hudson. Major Baker had to write to Governors Island, New York, in the middle of December in 1841, to explain the whereabouts of the new gun carriages for Castle Williams on the Island — they were in a vessel which had frozen tight in the ice 20 miles below the Arsenal. This delay, however, could undoubtedly be classed as an "Act of God."

The other waterway, the Erie Canal, caused trouble during this period also. The summer of 1841, the State of New York had widened the canal and wrecked the loading wharves which the Arsenal had built. At the same time, the deep ditch which

LIMESTONE BARRACKS — This limestone barracks building remains in use today as offices.

had been necessary in order to drain the new towpath made unloading of barges very inconvenient for the Arsenal workers. The final blow came in the winter of 1842 when the State suddenly stopped the water in the canal without notice, leaving the Arsenal without waterpower. Major Baker protested to the Canal Commissioners, who agreed to turn the water back into the canal if the Arsenal would repair a break which had formed in the canal and pay the lock-keeper's wages for the winter. The pressure of work in the shops forced Baker to do this, but he considered it an injustice to the government to have to pay for repairs and maintenance of a state-owned canal. After a year of polite bickering, the state agreed to pay the lock-keeper in the winter.

Work in the shops increased in the winters of 1841 and 1842, when leather working was initiated; harnesses, saddles, and bridles were made. In addition, many carbines were sent up from the Florida campaigns for repair. Much to Major Baker's disgust, most of the arms had broken stocks caused by the explosion of loose powder spilled in loading the gun. He, himself, had fired a gun of the same model 9,000 times, without such an accident occurring. Here again, the soldier had failed, and not the materiel. Baker suggested that the soldiers be taught to hold the carbine to the right instead of to the left while loading, so that no spilled powder could lodge between the receiver and the stock, thereby evading an explosion and necessary repair to the gun.

Ordnance materiel as a whole was interesting to Major Baker. He was much impressed when he witnessed a demonstration of "a bursting shell which exploded on striking the target" in 1843, and highly recommended it to the Ordnance Department. Admitting that these shells sometimes exploded prematurely and sometimes not at all, he pointed out that "with care and skill in their preparation, these defects would be rare." He also defended the inventors who had " ex-

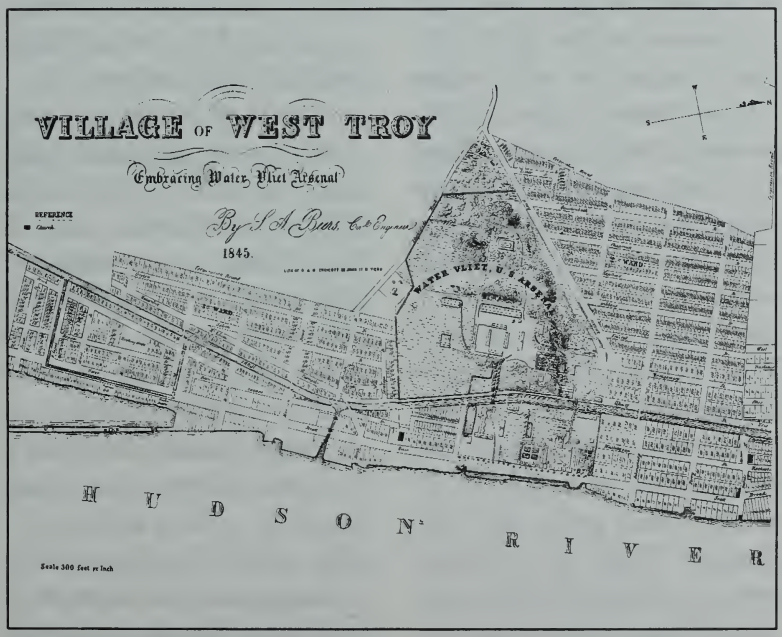
pended their means in bringing their invention to its present state" and suggested that they be allotted the funds necessary for further experiments. To far-sighted men like Major Baker, the Ordnance Department owes much.

Although life at the Arsenal, with expansion, had gradually become less intimate, Major Baker took a paternal interest in the enlisted men and championed their cause in Washington many times. When they were issued boots that fell to pieces in two days' wearing time, he wrote to the Quartermaster General; when they received new sky-blue uniforms in March 1845, he presented their complaints to the Chief of Ordnance. He stated that "the present sky-blue pantaloons and jackets that are issued to the army are so improper to men of our corps who are most of the time engaged in mechanical work or in handling, cleaning, and preserving all descriptions of public property, that I take leave to recommend a change to dark blue. The men themselves request it ... the overalls and jackets should hereafter be made of a dark blue cloth, the yellow lace be omitted and instead of it, a scarlet welt merely be inserted in the collar seam, all around the collar and a similar welt in the overalls ..." Since Major Baker was a man of action, he went to a tailor and had some uniforms made up as he had specified in his letter and sent them off as samples to the Quartermaster in Philadelphia. He explained that "these patterns are not, of course, intended as guides in workmanship or materials, but merely in color and fashion ... fit is so much better than that furnished by the public which the men always alter at their own expense, that I respectfully suggest the adoption of their general form and style."

The low pay of an enlisted man was a source of worry to Major Baker; in one case, he discouraged a man from enlisting because of the pay. He reminded the would-be soldier that "the situation of Artificer at $13 dollars a month, which is the highest

position you could hold as an enlisted man, would not be adequate to support your family. Another reason I could not enlist you now," he continued, "is that the present number of families at the post is as great as can be comfortably quartered." He recommended that the man come to the Arsenal as a workman at a dollar a day, so that his income would be $24 or $25 a month.

Any authentic tale of distress from the enlisted personnel was given a sympathetic audience by Major Baker. He went to a great deal of trouble to get a permit for the re-enlistment of a drummer boy who had been refused because of new regulations concerning age and height. Defensively, he wrote: "He has neither father nor mother, has been raised in the service where both his parents died, and he is usefully employed in the ma-



WEST TROY — Map drawn in 1845 shows site of arsenal within "West Troy" which would later become Watervliet.

chine shop beating out the work and meal calls." Baker was just as delighted as the boy when permission was finally obtained. When one of the soldiers had one hand blown off while loading percussion caps, he made great efforts to secure a pension for the injured man, as Congress at that time allowed no compensation for men wounded during peace time. To the Chief of Ordnance Major Baker wrote: "In war, Ordnance officers and men would necessarily be attached to armies in the field, exposed equally with other troops to the dangers and disasters of war. In peace, they are always liable to many more accidents and injuries than any other corps of the army, from the very nature of their duties, among which are those of providing and proving the ordnance, powder, and other materiel of service, the preparation of which is attended with great risk and danger. There is no reason why the soldiers of the Ordnance Department should be excluded from the benefits of those humane provisions which have been made for the unfortunate of the other coirps of the army." Not only the enlisted men at Watervliet Arsenal, but those in the Ordnance Department at large, were benefitted by having Major Baker in command during the formative years.

Others, too, were aided by Major Baker. Many requests for information about soldiers missing in the Seminole War were forwarded to the Arsenal; he was even willing to make inquiries for one mercenary female from Schenectady. She had been wondering whether her husband was "alive or dead, and if the latter, whether he left anything of value I could claim." Major Baker considered himself a public servant, and was extremely conscientious in all of his duties, which he performed willingly and well.

Major Baker's deep interest in the welfare of the Arsenal itself, as well as his attitude toward the employees, is characterized in a letter to the Master Blacksmith of the Arsenal, who had inspected and passed some very poor

iron for use in the smithshop. He wrote: "I deem it my duty not to permit the circumstance of the extraordinary failure of the axle trees yesterday to pass without endeavoring to derive from it some advantage to counteract the actual loss and the bad effect which such work cannot fail to produce upon this establishment. I have often impressed upon you the necessity of examining iron closely and have depended upon your vigilance and judgment in detecting such as might not be suitable for use.

"I cannot help thinking that in this business you have neglected to exercise care and attention required from one in your situation, and that application due from you would have prevented the result, so injurious to the reputation of the Public Shops, so mortifying to those who feel a pride in having none but good work done in them.

"Unless the Master Workmen feel an interest, and a deep one, too, in the operations, and exert themselves in conducting them with skill and economy, the public interests must undoubtedly suffer, and with them the reputation of the Master Workmen themselves, as well as that of the officer who is finally responsible. Thus, our own interests are intimately blended with those the public has confided to our care, and as we would preserve and advance our own, so must we watch and protect those of the public."

Major Baker, with his background, his experience, and his interest in the Arsenal, the Ordnance Department, and improvement of materiel for the use of the soldier, was an excellent officer to command Watervliet Arsenal during the next few years. War again necessitated expansion.

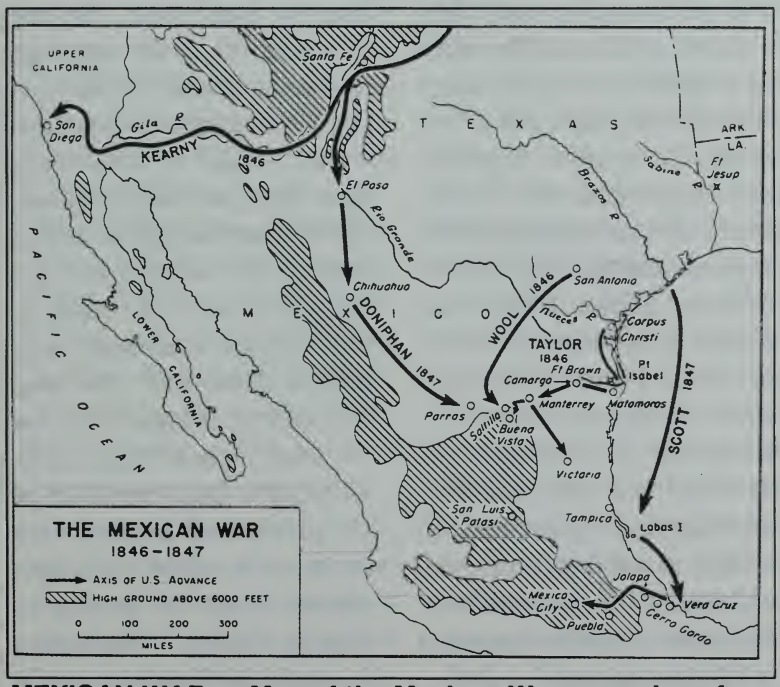
Chapter 3
The Mexican War

The United States was undergoing growing pains throughout the 1840s. Movement toward Oregon was but part of a general movement which had already spread toward Texas. Boundary lines were in the process of establishment, and argument was inevitable regarding Oregon, California, New Mexico, Mexico, and Texas argument which, it developed, was to be settled only be force. The question of the annexation of the independent power of Texas had become involved inextricably with politics and had been complicated by the fact that Mexico, long at war half-heartedly with Texas, protested its admission to the United States. Finally, on July 5, 1845, Congress met, unanimously accepted the terms of annexation, and framed a constitution which was ratified at the polls in October.

General Zachary Taylor went to Texas with 1500 men on June 15, 1845, with the sole duty of defending Texas, unless Mexico should declare war against the United States. When the Slidell Mission failed, the army left Corpus Christi and advanced across disputed territory to the banks of the Rio Grande, where they began to erect Fort Texas. In March of 1846,

Taylor was ordered to break up camp and retire, but refused. One week later he ordered the Rio Grande blockaded, having heard that two Mexican ships with supplies were at the mouth of the river. The Mexicans had to choose between starving or fighting. On April 24, General Taylor was notified that war had begun! The news was dispatched to Washington, and on Monday, the eleventh of May, the President delivered his message to Congress. After much controversy in the House, the next day a proclamation was issued declaring that, by act of the Republic of Mexico, a state of war existed between her and the United States. Once more supplies had to stream southward.

The first order for munitions for Texas troops was received at the Watervliet



MEXICAN WAR — Map of the Mexican War campaigns from 1846 to 1847.

Arsenal in August of 1845. A company of soldiers sailed from New York for Galveston, and the Arsenal was ordered to supply ammunition and battery wagons. Soon, however, large orders for Texas troops began rolling in and the tempo of work increased greatly. Instead of placing orders for 10,000 feet of white oak for gun carriages, the commanding officer now ordered 250,000 feet at a time, "at $40 per thousand feet." His orders for 500 or 600 pounds of canister shot increased to 200,000 pounds! All of the Arsenals worked together, and cooperated with the private manufacturers, in turning out supplies for the armed forces. Major Baker was forced to sign letters, "Yours in Haste," instead of his usual carefully polite, "I am, Sir, Respectfully, Your Obedient Servant!" There was also often an added postscript to letters to private concerns, urging that "the execution of this order should be hastened in all your power."

Four of the best Arsenal workmen were sent to Corpus Christi, Texas, in November for necessary work there with the Ordnance Department. No one at Watervliet had ever been to Texas, so that it necessitated thorough research on the part of Major Baker in order to chart the best and most economical route. Sea passage from New York to New Orleans would cost $50, but competition among the boats on the western rivers had lowered the cost of transportation by that route. So the blacksmith, the carriage maker, and the two armorers—"all respectable gentlemen"—sailed to New York and then to Philadelphia, where they bought overland passage to Wheeling, West Virginia, for $12 apiece. Boarding a river boat, they sailed down the Ohio and Mississippi Rivers to New Orleans, where they contacted the Quartermaster of the Army and learned "the most economical and expeditious mode of getting to Corpus Christi." Each man was paid $1.50 per day while traveling, except for Sundays, and they were to be paid for

their work at the prevailing rate in Texas. Later, a number of other groups of workers made this same safari from the Arsenal to the battlefront.

Additions in personnel were required at Watervliet, also. The year that the Mexican War began, there were only 250 workers employed, of whom approximately one-half were mechanics. Major Baker preferred enlisted men for Arsenal work, and requested an allotment of eighty, since there were only thirty-two at the time. He clearly outlined his reasons for the request to the Chief of Ordnance: "First, the very large amount of public property at this Arsenal and its great value (Inventory 1845—$2,174,192) requires it to be better guarded than it is now. Watchmen should be kept at night in the vicinity of the powder magazine, the storehouses west of the canal and among the buildings east of the canal. Our present force of enlisted laborers is too limited to turn off guard greater than three men. By having one day and three night sentinels, the guard should be drawn from a force of at least thirty men, especially as all the men are laborers and employed as such.

"Secondly, enlisted labor is more economical than hired labor. The total cost of eighty enlisted men for 365 days is $20,075; the cost for eighty hired men for 313 days a year comes to $24,257. Thirdly, enlisted men are safer than hired men when employed in magazines and laboratories. They become better instructed in the peculiar duties of Ordnance men, and when instructed are always available for field service and for duty at temporary laboratories that would be established during war, and at which skillful artificers would be indispensable. Public property, too, is safer when enlisted men are employed in handling and guarding it. They live within the walls of the Arsenal and feel an interest in the safety of the place and in its reputation. They are influenced by an esprit de corps that hired men do not feel. They are present at night, too, forming an efficient fire company for the

safety of the buildings." Faced with such logic, the Ordnance Department granted eighty enlisted men to the Watervliet Arsenal.

The War Department, in turn, wanted as many men as possible to enlist for active duty in Texas and Mexico. Advertisements were placed in the Albany papers for recruits, and anyone who persuaded a man to enlist and brought him to the local recruiting station, received a bonus of two dollars. One patriot who enlisted at the Arsenal had the peculiar experience of going to Texas, getting lost, and returning to the Arsenal without ever having seen the army unit to which he had been assigned. Explaining the case, Major Baker wrote: "He was enlisted here on the 20th of July, 1846, and left here on the 22nd of August for Texas. He states that the vessel left him at Galveston whence he returned to New Orleans where his clothes had been carried by the "Neptune," which ship, after shifting her cargo to the Brig which was chartered for the purpose, sailed for that city. He says he knew not what to do with himself, having no papers to show, and finally determined to return to this place after getting the means by laboring in New Orleans." Although he wished to remain at the Arsenal, he was not received with open arms and, as he had "rendered no service to the Government nor received any pay," Baker discharged him from the army and called the matter finished. Deserters were also a problem and brought $30 a head when turned in! Major Baker did not relish this, however, and as soon as a deserter was brought to the Arsenal, begged some other unit to take him. When a soldier had to stand guard over a deserter, it meant one less worker in the shops!

Actually, shop work involved many problems. The Canal Commissioners notified Major Baker in February, 1846, that the canal would be drained for repairs within a month. The small steam engine which had been installed some years before was capable of running only

a few of the larger machines, and would not compensate fully for the lack of water power. The shops immediately started operating at night, by candlelight, in order to gain an extra quarter-day's work before the waterpower was stopped. Great precautions were necessary, in order to avoid fire, and Major Baker asked the Ordnance Department to consider buying a steam engine large enough to run all the machines in the shops. As a temporary measure, some of the machines were adjusted so that they could be transferred from waterpower to steampower in a few hours, and some new lathes and a bullet press were installed. The manufacture of bullets was an innovation, necessary because the supplies from the private manufacturers were insufficient to meet the demand. The number ordered from the Watervliet Arsenal

SOLDIERS OF 1840-50 — Typical arsenal soldiers of the 1840s. From left, infantry corporal, artillery officer, ordnance officer and first sergeant.

increased until, by the spring of 1847, two million bullets were required. To fill these orders, Major Baker wrote to all of the other arsenals and depots, begging for any spare musket, rifle balls, or buckshot that they might have. Rooms and dining halls were prepared at the Arsenal to accommodate the two hundred boys hired to make cartridges.

When President Polk ordered the Americans to advance to the Rio Grande, the Watervliet Arsenal was also ordered to produce supplies at all possible speed. Baker replied that he was doing everything possible with his "twenty-three smithy fires," and had put "three traveling forges into operation for small work." Soon the Arsenal was shipping as many as 165 gun carriages at one time! Yankee ingenuity had been demonstrated by the employees in finding better and quicker methods of production. In August of 1846, a "small siege train for General Zachary Taylor" was shipped, consisting of these listed supplies: "Four 18-pounder medium iron guns, two 8-inch siege howitzers, two 8-inch siege mortars and beds; for 18-pounder cannon, 800 cannon balls, 100 grape rounds, 900 bags, and 800 sabots; for 8-inch guns, 400 shells, 50 canisters, 400 sabots, 600 fuzes, 400 mortar bags, and 600 mortar fuzes; 450 howitzer bags, 2500 priming tubes, 500 portfires, 300 pounds of slow match, one siege gun, two jack screws, six prolonges, twelve drag ropes, 200 feet trace rope, six hand barrows, one traveling forge with tools and materials, one battery wagon with tools and materials, harness for twelve horses for two 8-inch howitzers, and ordinary harness for twenty-four horses." Transportation from the Arsenal to Texas for this enormous amount of materiel was quite a problem. Luckily, it was August, so that the Hudson was navigable. It was fortunate that a railroad, the Housatonic, was completed in December 1847, and the war supplies could continue to move out of Troy. The first railroad shipment was composed of

traveling forges, used mainly to shoe the horses while an army was in the field, and they were sent to West Point by way of Bridgeport, Connecticut, and New York City!

Private manufacturers also had their troubles with transportation. Even in the first year of war, the Arsenal workshops were using four or five barrels of musket powder per day for cartridges, and there was a perpetual shortage. Steamers on the Hudson which carried passengers refused to carry gun powder as cargo, so that the supply had to be moved by towboat ordinarily. To add to this drawback, shortages of raw materials were not uncommon. The Arsenal had a difficult time buying enough coal tar, while used copper and brass needed for gun carriages was impossible to find. Major Baker wanted to melt down some of the cannon, relics of the Revolutionary and other wars, which were stored in the Warehouses, pointing out that they were useless as artillery. However, instead, the Chief of Ordnance gave permission to buy new copper and brass. Some rush orders which came through pointed out new shortages. One of these was for "10,000 infantry accoutrements to be made up as rapidly as possible." White leather was so difficult to obtain that the workshops were forced to make some belts of russet leather, regardless of the uniform regulations. The order was finished out with black belts which had been stored at the Arsenal after earlier wars! Similarly, when Major Baker was ordered to ship 600 light cavalry sabers immediately and found that he didn't have that many, he sent his whole supply, which consisted of sabers with brass scabbards and hilts, with dull steel hilts, with bright steel hilts, basket hilts, and Prussian hilts. The storehouses were emptied.

One material in little demand during the Mexican War was rubber, although one private manufacturer made some rubber-coated tents and offered them to the Arsenal to demonstrate their waterproof qualities. Major Baker returned the tents, informing

the manufacturer that "by a few weeks exposure, the whole surface has cracked and rain storms drive through." He also destroyed the company's hope for orders for rubber haversacks and portfire cases by declaring that there was "no particular object in substituting India rubber for leather, ... unless the India rubber can be made as strong and cheap and durable as leather." As an experiment in the workshops, gun powder barrels were lined with "India rubber" to protect them against dampness, but this was discontinued when reports from the field complained that the rubber had a bad effect on the powder. Plastics were unknown at this time, so that when a transparent, unbreakable material was needed for the lanterns being made, mica or transparent horn was ordered. White oak timber had to be imported from Canada, and cheaper woods—ash for rammer staves, hickory for hand spikes, white wood for shot blocks, and maple for rammer heads-were still obtainable in New York or the New England States.

Unfinished materiel was sometimes shipped from the Arsenal, due to the insistent demands of the men in battle, usually followed by a letter of apology from Major Baker! A number of times, gun carriages had to be shipped unpainted, but were accompanied by a keg of paint in hopes that someone could find time to paint them before they had to be used. When it was impossible for the Arsenal workshops to keep orders filled, subcontracts with private manufacturers were negotiated. In the spring of 1847, orders for 592 sets of harness were turned over to a private company, although the post harness shop was turning out 300 sets a month!

Ammunition was manufactured in the Arsenal laboratory that same spring, as quickly as possible, and immediately shipped. On the average, in two weeks time, 1,073,000 cartridges were sent to the troops! The cartridges were for muskets, rifles, carbines, pistols, and the flint and percussion arms.

The percussion type of arm was fairly new, and the manufacture of percussion caps was an important item of production at the Arsenal during the Mexican War. Major Baker predicted that "very shortly the flint muskets are to be converted into percussion and then all our troops will be armed with percussion arms." His interest was heightened by the fact that one of the Master Workmen at the Arsenal, a Mr. R. M. Bouton, had invented a machine to make percussion caps which was far superior to any other. The French process, which was probably the best at that time, consisted of four operations, necessitating the use of three machines and three workmen, while Mr. Bouton's needed but one workman, who could perform one operation with two machines! It was estimated that one man could manufacture 60,000 percussion caps per day, while the French method would require seven persons to produce 50,000 in one day. In 1848, Major Baker wrote that "... during the last two years the Department has been enabled by means of these machines to supply the demands of the Service which, without them, could not have been as well done, and its increasing means are intended to meet the increasing demands... an invention that is to be usefully applied to our military service for the future and is calculated dto meet the heaviest requisitions with unequaled promptitude ... an invention which gives us the means of rapid and economical supply of an important article of war, means that it is believed no other nation possesses." Two of these machines were made in the Arsenal shops for Navy use during the war, one at the Washington Arsenal and one at the Navy Yard in Washington.

Back of the experimentation and increased production were the usual misfortunes and headaches which accompany supervision of a busy manufacturing establishment during wartime. Two fires marred the fine record of the Arsenal in March 1847. One, not so serious, destroyed the roof of

the old north gun shed and all the property contained in the upper room, and Major Baker explained that one of the "temporary expedients compelled by the increased demands" had been the "making of a room under the projecting roof of this old shed for the purpose of inspecting shot and shells, and putting a stove in it carrying a pipe through the roof. A spark from the stove pipe set fire to the old dry shingles of the roof, causing its destruction." He would not have been quite so upset if this accident had not closely followed a fire which had resulted in the deaths of an elderly man and a boy—Arsenal employees. "That accident, it appears from examination before the coroner and jury, was caused by one of the lads at work in the fuze driving room kicking an empty fuze that lay on the floor. The dust of the composition which was upon the floor was ignited by the friction of the boot upon the floor and the fire communicated to the several pans of composition, causing an instantaneous combustion. The wounded were all burned, but none injured by bruises. The composition burnt without any explosive force." This marked the first reported death of any of the Arsenal employees—the recording that "an elderly man and one lad died a few days after their injury."

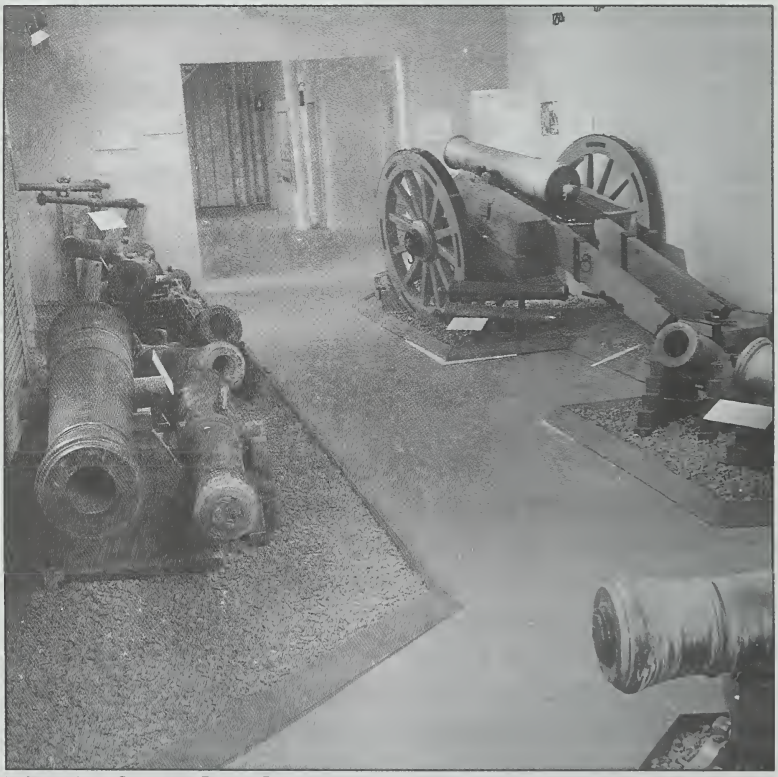
Applications for increased wages were presented to Major Baker in the spring of 1847, so he made a survey of local working conditions and reported his findings to the Arsenal employment office. He discovered that the Arsenal wages coincided very nearly with those paid in Albany and Troy and, moreover, he considered that the "greater permanency in a situation here, certainty of payment, and exemption from militia and juror's duties" were considerations that should carry weight with the dissatisfied workmen. His conclusions undoubtedly disappointed the men, as he stated that "it would be highly inconvenient ... to follow the rise and fall of wages produced by causes that do not affect the operations of this

public establishment. At the present time, however, I find by inquiry that there has not been an advance of pay at any of the shops I visited, and that none is contemplated. As I was told, "The product sold for no more now than last year!" With this economic basis, Major Baker found that he could not "consistently" raise the pay in the shops, but, since he wanted to keep his skilled men, he suggested that they consider the subject "fairly," at the end of which he thought that they would realize that "their present situation is quite as good as employment in private shops, even at larger wages, for a limited time."

The proper moment for agitation for higher wages had already passed, since by the summer of 1847 most of the hard battles of the war had been fought, and fewer orders came into the Arsenal for supplies for the troops. The great victory of Cerro Gordo in January of 1847 had routed the entire Mexican Army, and since that time peace terms had been discussed, although the war dragged on through various Mexican cities, the guerrilas retreating before our army, until finally in November a treaty was signed and sent to Washington. Most of the Arsenal workmen who had been making shells were discharged during the summer, as a large quantity of ammunition had been made in anticipation of future orders, and a sufficient supply was stored. There was time that summer to return to plans which had been laid aside during the busy wartime months—work on the double officers' quarters was started, and the big steam engine for which Major Baker had been longing was ordered from a Troy manufacturer. When the engine had been installed in the shops, Baker wrote to the Ordnance Office describing the excellence and beauty of the 35-horsepower machine with the ardour of a true machine-lover. Now the Watervliet Arsenal need not be dependent upon the fickle water supply of the Erie Canal; a work schedule could be planned with assurance, and without thought to whether

the machines would be usable in the Arsenal shops.

Civilians showed an interest in the Arsenal at that time, especially since it was a nice little excursion from either Saratoga Springs or Ballston Spa, the most fashionable summer resorts in America. Major Baker wrote to the Ordnance Department: "You are aware that during the summer months thousands of persons, among them travelers from all parts of the country to the great watering places, visit this Arsenal which, with its extensive workshops, its depot of arms and its collection of Revolutionary War trophies, has become an object of very general interest and curiosity. Enquiry is frequently



WAR TROPHIES — Cannon captured during the Revolutionary and Mexican Wars are displayed in the impressive Watervliet Arsenal Museum collection.

made now after Mexican trophies and, as there are several at Governors Island, access to which is far less convenient than to this Arsenal. I have determined to request that a few of the guns and shells may be sent here where public curiosity may be gratified by their examination." The "public curiosity" itself must have been gratifying to Major Baker.

On February 21, 1848, the Senate ratified the peace treaty, and it was hurried by special commissioners to Mexico where, on the 29th of May, it was duly ratified by the Mexican Congress. That same day General Butler announced to the army that the war was over and that the homeward march would start at once. The primary mission of the Arsenal must be changed from production to the more prosaic repair and storage of arms.

Baker, now brevetted a Lieutenant Colonel in recognition of his command during the Mexican War, was faced with the task of conversion. Before the ink was dry on the peace treaty, the Watervliet Arsenal received orders to "make all practicable reduction in the number of men hired," which order was repeated at intervals, along with the reduction of the number of enlisted men allotted to the Arsenal to await their discharges. Upon leaving the service, soldiers who had actually fought in Mexico or Texas received an extra three months' pay and a land warrant for a portion of government land, while heirs of the soldiers were also entitled to land warrants so that Colonel Baker was kept busy answering their queries, and years later clerks were still searching the old records of enlistments to verify claims for land bounties.

During the thirteen years that elapsed between the Mexican and Civil Wars, the two main projects carried on at the Arsenal were the storing and repairing of arms returned from the war, and the altering of small arms from flint to percussion. For many months, thousands of boxes of supplies poured into the Arsenal. The great majority of the materiel was oiled and

stored at the Arsenal, until the storehouses were at the bursting point, some was repaired, cleaned, and returned to the proper army unit, and large quantities of metal supplies were so badly rusted from exposure that they were discarded. The disposition of the Ordnance Storekeepers, as well as the storehouses, were at the breaking point—one lot of 1400 boxes was received lacking invoices or any indication of shipping point, and various oddities such as surgeons' instruments or uniforms were found mingled with rifles and sabres!

In an effort to clear out the Arsenal storehouses, public auctions of large stocks of small arms were held every few months, beginning in 1849. Various dealers bought arms and sold them in Africa and Brazil, in competition with British and Belgian dealers, and those who were not dealing in this market refused to bid more than $2.50 a piece for muskets, although they admitted that the United States Army muskets were better than those made in Europe. Such prices were considered too low by Colonel Baker, who hinted darkly that the bidders made agreements among themselves before the auctions began, and once he stopped the sale when the highest bid was forty-five cents per musket. Many of the muskets, rifles and pistols bought by "Emigrants to California" were purchased from dealers whose supplies had come from Watervliet Arsenal.

Very few employees now remained at the Arsenal; reductions were systematically made until, two years after the end of the war, Colonel Baker wrote: "There are today only forty-eight hired men on our books, a smaller number than they have shown in the last sixteen years." The number of enlisted men had dropped to thirty, and there were four commissioned officers. In 1849, Colonel Baker had written to a would-be employee that the "hired citizens" at the Arsenal had been reduced from four or five hundred to less than seventy, and that he had been "compelled, in the discharge

of my duties, to dispense with the services of a great number of very excellent workmen." Funds for a new hospital had been received but, with so few men needing medical care, plans were abandoned. In 1848 a brick carriage storehouse was completed, so substantially constructed that it was still in use as a firehouse in 1946, but the only other building erected after the close of the war was a powder magazine. The thousands of barrels of gun powder, for which there was now little use, urgently needed a new storehouse, which Colonel Baker designed and built in 1849. Several other Arsenals copied Watervliet's "West Magazine," which had numerous interesting and practical points. No iron was used in the building, since that might "attract lightning," and its capacity was 3500 barrels, with 100 pounds of gun powder to the barrel. To further guard against explosion, the magazine was placed far back up the slope from the

FIREHOUSE — Originally a brick carriage storehouse, this building was still in use as a firehouse in 1946.

WEST MAGAZINE — The design of this powder magazine was copied many times. The sturdy structure is still in use today.

Hudson, away from the principal workshops on the river road. The Arsenal stone walls were extended to include the new building, as that section had formerly been barren of buildings, and an individual stone wall was built around the new magazine to protect it from fire. The open field was "barren of nearly everything except shrub oaks, and it is next to impossible to keep them down," as Colonel Baker wrote, and he was afraid that "in the season of dry leaves," fire would spread very easily to the powder magazine.

Among the improvements of this era were telegraph and gas lighting. The first record of a "telegraphic dispatch" being received at the Arsenal was in 1848, and in 1849 Colonel Baker strongly recommended that gas lights be installed arguing that the lighting around the quarters, barracks, and work shops would so aid the guards in their duties that confusion would be prevented, and consequent loss of time and property in case of fire. Moreover, he offered to have his enlisted men do the work, with the pipes furnished by the "old iron about the place." The Ordnance

Department was not interested at the time, although five years later gas lights were installed.

Colonel Baker himself was not favorably inclined toward the expansion of the railroads when, in his opinion, it affected the Arsenal adversely. Asked about the request of the Albany Northern Railroad to lay tracks along the Hudson, crossing the Arsenal grounds, he fumed: "The principal workshops are situated near the south of the river front, but about 184 feet back, or west, from the curbstone on the east side of the public road. The gun carriage shop fronts the river in its entire length of 165 feet, and the finishing shop, its entire breadth of 50 feet. So the workmen employed within them have a view of all that may be passing on the road and river. I have found this circumstance objectionable, as the almost constant passing of steamers, other vessels, carriages, etc., attract the attention of the workmen who very naturally desire to gratify their curiosity, to the great loss of time and money in the aggregate to the United States.

"If to the present objects should be added locomotives with their trains, their steaming, whistling and other exciting performances incident to their operations, the Ordnance Department may judge whether the evil above described might not become more general and serious. However, some simple means, such as painting the glass windows of the shops or interposing screens or blinds might be adopted to break off the view of the road. The rails would necessarily cross the wharf near the road, thus cutting it off from the other grounds. Or rather, interposing an obstacle to the present free and safe use of the public wharf by teams, which in time of active operations at the Arsenal are frequently employed in considerable numbers. And as vessels are not infrequently loading or unloading powder and fixed ammunition, it may be readily judged whether the obstacle with its locomotives would be a dangerous one. Indeed, during the Mexican

War there were times when we were compelled to cover nearly the whole surface of the wharf with these combustible stores, guarding vigilantly against the possibility of accidents from fire." The Ordnance Department sympathetically agreed with Colonel Baker that the disadvantages outweighed any advantages that the railroad might bring, and the company was denied the privilege of running their trains through the Arsenal grounds.

The opening of the western United States brought new problems to be solved. The soldiers who crossed the great plains and deserts to Sante Fe and San Francisco found the old type gun carriage unsuited to the terrain, but Colonel Baker developed a new type called a "prairie carriage", which was much lighter than the old models and thus suited to swift pursuit of Indians across the plains. Departing from the customary olive-drab paint, he substituted a cream color which, he explained to the commanding officer at Santa Fe, would "better reflect the sun rays, considering your desiccating climate." Perhaps the Colonel was a visionary in the art of camouflage. Prairie gun carriages, harness, ammunition, and howitzers were shipped from the Arsenal to Fort Leavenworth by way of Buffalo, Chicago, and St. Louis during the summer of 1850, in order to supply the large detachments of recruits on the march to Sante Fe or Fort Laramie.

Other inventors than Colonel Baker were busily improving their weapons for war during this period of peace, and he was constantly being requested to make models of various inventions, which he was unable to do as the standing rule of the War Department was that an inventor had to offer his ideas in a concrete form, at which time the arsenals would put them on trial. To one man who had an idea for a "pointed percussion shell, the Eagle shell... to astonish the beholders by destroying the British fleet," Baker wrote: "I fear that you are spending your time and money with

little prospect of success. The many ingenious contrivances for improving cannon and shells have, so far, all failed in practice...."

Exactly thirteen years after he had assumed command—October 10, 1851—Colonel Baker left the Arsenal. His fine record and knowledge of ordnance work gained him the next important duty of inspecting all of the army arsenals. Shortly thereafter, he was ordered to take command of the new Benicia Arsenal in California, but such a trip in the 1850's was a perilous journey, and Baker's health was failing. He requested the Secretary of War, Jefferson Davis, to grant him a year's leave before setting out for the Pacific Coast. This was a modest request, as he had not asked for one day's leave in twenty years, but it was refused and Colonel Baker, feeling that he would never live to return to the East again if he went to California, resigned from the Army. The Ordnance Department thereby lost one of its most outstanding officers.

Major John Symington took over the command of Watervliet in 1851, and ironically was kept busy for the first years furnishing materials and workers to build the very Arsenal which Colonel Baker had refused to command—Benicia. Production in the 1850's was, however, extremely limited for the most part. The small percussion laboratory stood empty until it was enlarged and altered into a hospital, as the manufacture of percussion caps was now being performed at Frankford Arsenal. Thousands of small arms were altered from flint to percussion, however, and a few orders were filled in the shops for new forts in the West and expeditions against the Indians. Large amounts of timber for gun carriages were purchased and placed in the storehouses to season—a precaution which proved an extremely valuable aid for production during the Civil War.

A few changes did take place during this lull in production, one of the most important of which was the reorganization of the Arsenal

workshops. Foremen were placed in charge of the various shops, in place of a Master Workman, and were responsible to a general superintendent. This general scheme, with variations caused by the extended scope of operations, is still employed, with excellent results. Gas lighting was installed in 1853, but did not prove as efficient as had been hoped; the gas flow stopped at irregular intervals, usually in the early evening, when most needed. One event cost the Arsenal its Commanding Officer. In 1854 a serious fire which occurred in the Commanding Officer's quarters confined Major Symington to his bed because of "indisposition caused by the excitement and fatigue and inhalation of smoke." Thereafter, he was frequently ill and left the Arsenal in 1856, although his command was not formally relinquished to Major Alfred Mordecai until June 23, 1857.

Major Mordecai found that affairs at the Arsenal were in need of a firm hand. Major Symington, because of his health, had been unable to attend to many details, and the three young lieutenants who had been in temporary command hesitated to make any important decisions. A graduate of West Point in 1823, to which he had been appointed from his native state of North Carolina, his brilliant career as a cadet had been followed by one equally brilliant as an Ordnance officer. Two years before coming to the Arsenal he had been a member of a three-officer committee to tour Europe and report to the Secretary of War on military developments, especially in the Crimea. He had had wide experience in ordnance work, both in development of and experimentation with guns and gunpowder, and as the commanding officer of arsenals. He knew exactly what was necessary in the planning and management of arsenal work, and set about it with no delay. Arsenal activity had grown indistinguishable but it again emerged with well-defined outlines.

Chapter 4
The Civil War

The period of prosperity in the United States from 1850 to 1860, in which material progress had been greater than any previous decade, resulted in advancements which were to be of great aid in Watervliet Arsenal's job during the war, such as the 22,000 miles of railroad which were built, and the tens of thousands of telegraph lines which were erected. The first year of Major Mordecai's command — 1857-58 — also resulted in internal advances for the Arsenal. There was time, as well as funds, to devote to the study of new machines and methods and efforts to increase the efficiency of the old machines.

Less than two weeks after his arrival at the Arsenal, Major Mordecai recommended changes in the building plans to the Ordnance Department. First he asked for an office building, reporting that the old offices on the original square were not only small, but were so situated that in the "spring freshets," they were inundated. In the spring of 1856, "the water was four and a half feet deep on the floors of the principal rooms and the drawing office, which stands lower, was filled nearly to the ceiling." The "conse-

quence" of Major Mordecai's request was that the new offices were completed in 1861 on the east bank of the canal, directly in front of the main gate, and were used until 1901. Another building built in 1859 was the Iron Storehouse, which was still in use during the Second World War. He planned well and executed his plans with care, as witnessed in the production end of the Arsenal as well as the construction.

Examining the methods of work in the shops, the Commanding Officer discovered that some which had been outmoded were still being employed. For instance, the Arsenal had never kept large quantities of raw materials on hand, except for timber, and it was customary to wait until an order was received before buying the materials, which resulted in delays in production. Realizing this inefficiency, Mordecai requested that large amounts of iron of all types be bought and stored until needed. Because of his forethought, the Arsenal was better prepared when the Civil

OFFICES — Much-needed new office space was completed in 1861 on the east bank of the canal.

War orders poured in than it had been at the inception of any previous war. One of his improvements was a great help to the field soldier. Sawdust had always been used to pack cartridge balls for shipping, and was continued after the conical shot with grooved sides had been produced. Thus the grooves of each bullet had to be cleaned by hand, since the oil from the molds clung to the bullet and the sawdust attached itself to the oil, until Major Mordecai concluded that shavings or tow were better for packing and discontinued the use of the sawdust.

A source of constant annoyance in the shops was the old bullet press which had been purchased some years before and which was constantly in disrepair. The new and vastly improved press built by the Arsenal caused a stir in Ordnance circles both in America and in Europe. When the new machine had been adjusted, it made 33,000 bullets per day, as compared with the old quota of 290,000 per month, and the Chief of Ordnance immediately ordered one for the Washington Arsenal. However, when the $900 press had been completed, the State Department requested it to add to the shipload of gifts which the United States was sending to Japan in an effort to persuade that nation to open its ports to trade with America, and the ship sailed for Jeddo, Japan, in the summer of 1860, leaving only one good bullet press in the United States with no prospect of another in the near future. Major Mordecai, knowing that his own machine shop was useless until the new floor had been laid, thought of an ingenious plan! The foreman of the machine shop, who had done most of the work on the press, sold the plans to a Troy machine shop — the press had not been patented, but could be seen by all visitors, so that there was no secrecy involved — from whom the State of New York ordered a bullet press. It was ready when the Civil War began, whereupon the State sold it to the United States for $1,800. Another machine which created interest was an apparatus to mea-

sure the velocity of projectiles by electro-magnetism, which had just been invented by a Belgian army officer, and Major Mordecai was appointed to buy two sets of the apparatus.

Pro-slavery and anti-slavery agitation swept the country in 1859, culminating in the rioting at Harper's Ferry, the seizure by the rioters of the United States Arsenal, the trial and hanging of John Brown, who had formed a secret association for the liberation of slaves buy a general insurrection, and the rising feeling between the North and South. By 1860 the states in the South were threatening secession if a Republican president should attempt to assume the administration of the government and, when Lincoln was elected, they wavered between delay and immediate disunion. South Carolina, having decided to secede as quickly as possible, had to have arms. Drayton was appointed an agent, and by him negotiations were carried out for the purchase of government arms. According to the Comte de Paris, in his History of the Civil War in America, the tents and artillery harness were to come from Philadelphia, the arms from the Watervliet Arsenal. There was no time to be lost, as the Cabinet might break up any day on differences of opinion with the President as to the right of secession and the new Secretary of War might stop the muskets going South, therefore, Drayton visited Mr. G. B. Lamar, President of the Bank of the Republic in New York, and asked him to make an offer for the muskets in order to conceal the purchase. He consented and the Watervliet Arsenal was asked to ship 10,000 muskets when ordered by Lamar. November 20, 1860, the State Convention met and signed the Ordnance of Secession, proclaiming the State of South Carolina an independent commonwealth. By December 30th, of all the property of the United States in Charleston and its harbor, Fort Sumner alone remained under the national flag.

As a native of North Carolina, Major Mordecai was

extremely worried by the turn of events. In January 1861, he wrote to an individual who wanted to make experiments on steel for gun carriages that "the troubled state of affairs might prevent the tests being made," and in February, anticipating the order to come, he requested that 1500 pounds of refined nitre be sent to the Arsenal. Routine orders for forts were ignored and supplies were sent to the New York Arsenal "at the urgent request of Major

CIVIL WAR SOLDIERS — Standing in front of the old barracks are, from left, an infantryman, artillery officer and cavalryman.

Thornton...to enable him to comply with a pressing call for the General in Chief". Despite his desire to obey all orders and his obvious efforts, Major Mordecai began to experience criticism and difficulties from various sources because of his status as a North Carolinian. His feelings on the subject are well expressed in a lengthy complaint to the Chief of Ordnance in March 1861:

"Some weeks ago Lieutenant Arnold called on me and stated that General John Wool, Commander of the Department of the East, had directed him to speak to me with regard to a report which the General had heard that some one in West Troy was making fuzes for the South. And that a foreman in the Arsenal had assisted him in the work. I replied that I knew nothing about the matter and that if General Wood wished to obtain information about the operations of the Arsenal, he had better apply to the proper authorities in Washington.

There the conversation ended. I had no intention of being uncivil, but as this was the first occasion which had occurred with me personally of interference with the affairs of this Arsenal on the part of the commander of the Department of the East, I thought it my duty to decline making any explanation which would recognize his right to demand it.

"I need hardly say to you that the manufacture of military supplies of all kinds is constantly carried on in various parts of the country. It is a matter of public notoriety that for many years past, gun carriages and their implements with ammunition for cannon and small arms have been made for sale in Troy and West Troy just as arms have been made at various establishments in many places and states. Until the late unhappy occurrences at home, the principal markets for such articles have been in England, Mexico, and South America.

"Neither at this Arsenal nor at any other, so far as I know, has any secrecy been attempted as to the mode of

manufacturing supplies of this kind. Respectable strangers are every day conducted though our workshops with every facility for examining the operations. Workmen are from time to time discharged who are familiar with the different kinds of work and the tools used, so that it is impossible to prevent this kind of work from being done in private establishments. I am now employing two private workshops in Troy to assist me in making brass fuze plugs to hasten the execution of your orders. It is not necessary therefore to resort to the supposition of improper complicity on the part of the foreman at the Arsenal to account for the possession by private parties of the means of preparing fuzes or other military supplies. And I do not believe that any foreman here has made an unauthorized use of his opportunity in this respect.

"It is to be regretted that on such apparently slight grounds, General Wool should have thought it necessary to make an imputation of censure of my conduct of the business of the Arsenal. For I can regard in no other

FUZE PLUGS — Moulding brass fuze plugs for eight- and ten-inch shells.

light his suggestion in connection with this matter that 'the Watervliet Arsenal should be subject to the inspection of the Commander of the Department of the East.' Otherwise why should not all the other Arsenals within the limits of the same department be made subject to the same inspection? 'Inspection' I take to be a milder term for 'control.' I invite, however, the most rigid scrutiny into my administration of the Arsenal and I trust in common justice no effect will be given to the imputation referred to until a scrutiny shall have been made by a court of inquiry. With regard to the expedience of placing this Arsenal under the control of the department commander, I have to say that without wishing to withdraw myself or the other officers of the Arsenal from the supervision of any superior authority, I think it must be injurious to the public service to place the business of an Arsenal of construction or the services of its officers at the disposal of a commander whose orders are not communicated through the Colonel of Ordnance. In such case, a conflict of duties would be inevitable. The case resolves itself simply into the old precept, 'No man can serve two masters and serve them well.'"

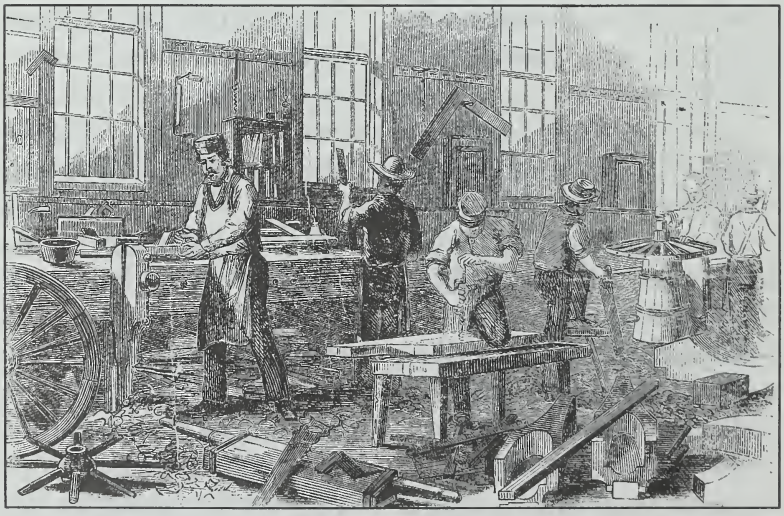
The Chief of Ordnance and the Adjutant General received letters from General Wool stating that a Southerner should not be left in command of the Watervliet Arsenal. Feeling that his honor had been doubted and his character insulted, Major Mordecai wrote to the highest army officials to ask what specific charges had been made against him by General Wool, but before he received an answer the actual fighting had begun and the Arsenal was deluged with orders. Despite the evident hostility that surrounded him, Major Mordecai hurried the workmen in the shops, rushed the shipment of orders and urged private manufacturers to fill requests from the Arsenal in the shortest possible time. Illustrating the reaction of the Arsenal to the first rush of war orders, he wrote: "The

work was carried on as far as practicable night and day for more than a week with the same set of hands. As no further instructions have been received relative to the unfinished part of these orders, I shall continue to execute them as fast as possible and I am making arrangements to fill up the workshops to their greatest capacity. The absence of waterpower, the canal still being empty, is a great inconvenience." The shops were lighted with gas so that night work could be carried on, and for the ammunition laboratory where an open gas flame was dangerous, gaslights backed with reflectors were placed outside the windows.

The task of supplying the Federal troops with arms and ammunition which fell to the Ordnance Department was extremely difficult, especially since both the government armories and private manufacturers were insufficient to meet the demand and time was required to establish new sources of supply. The Government, although willing to encourage private enterprise, wanted to avoid being controlled by it, so largely extended its own establishments. In the South there were no private establishments for manufacturing arms, the North having supplied the whole Union in the past, and Harper's Ferry was the only government establishment. They had to erect factories, nearly all of which were at the expense of the various states but eventually were placed under the exclusive direction of the central government, and the Southern states obtained supplies of arms and ammunition from Europe.

In April of 1861, the Confederates determined to commence hostilities, as the moment for striking a decisive blow had arrived and it was necessary to force those States which still hesitated into the war by making a direct attack upon the Federal flag. On the twelfth, all the batteries leisurely erected along the beach opened a converging fire on Fort Sumter and with its surrender on the thirteenth, the war had begun. The Watervliet Arsenal had been

awake to the impending danger before this, however, for the southern states had seized the forts and property of the United States along the Gulf; six states had left the union; and senators and representatives had left Congress. Orders for arming forts in the North had started to pour in during March, and on April 9, the Arsenal reported "we are fabricating and issuing by night and day in conformity with instructions." All during April orders from the Arsenal to private manufacturers were not able to fill such huge orders as those for one million percussion caps, two million primers, etc., each commanding officer of an arsenal contacted the other arsenals and government establishments but each received the same answer: "We do not have enough to fill our own orders for supplies." To add to the confusion, there was danger of Washington, D.C. falling to the rebels and on April 23, Major Mordecai wrote: "For fear of interruption of the mail communications with Washington, I wrote directly to Frankford Arsenal to furnish the two million primers."

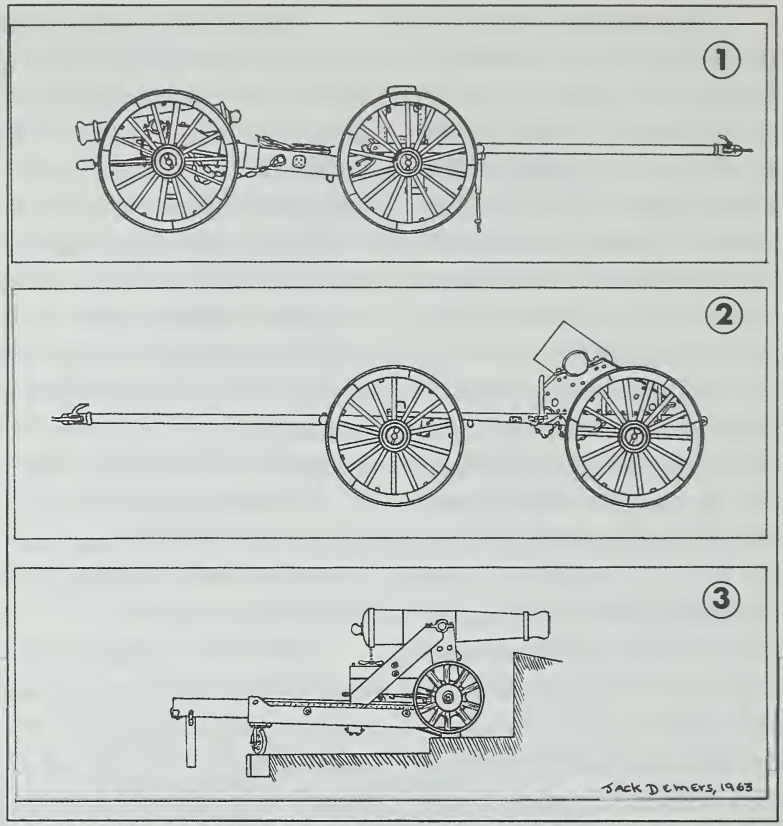


CARRIAGES — Fine craftsmanship went into making of gun carriages during Civil War.

The animosity that continued to be directed at Major Mordecai was more than he could bear in silence. On April 23, he wrote another letter to the Chief of Ordnance: "I have to acknowledge the receipt of your letter relative to 'reports and rumors' concerning the character of parties employed in making shot and shells for this Arsenal. It must be obvious to you that if the commanding officer of the Arsenal is to be subject to the surveillance of irresponsible persons who are interested in misrepresenting his actions, and still more, if he have not the confidence of the head of the Ordnance Department, it is impossible for him to discharge his duties properly. Anticipating the peculiar difficulty which I should have, under the present unhappy circumstances of the country, in giving satisfaction to the government and to this community in whatever manner I might perform my work, I wrote to you eight days ago requesting that you relieve me from the command of this Arsenal.

"I can hardly suppose that you received that letter, or I think you would have noticed it in some way. But knowing how much you must be pressed by business, I have waited as patiently as I could, and in the meantime I have continued assiduously to discharge my duties to the best of my ability. Respectfully, but urgently, I renew my request to be relieved from duty at this Arsenal and to make sure of your receiving this letter, I send it by the hand of Lieutenant Porter."

While awaiting a reply from Washington, he carried on the ever-increasing volume of work at the Arsenal which was complicated by the fact that not only the Ordnance Department, but the officers in the field, were authorized to call on the Arsenal for supplies. Excerpts from various communiques reveal the confusion — "The orders of Colonel Brown took every barrel of cannon powder from our magazine" — "Almost all the harness for field service has been drawn from the Arsenal for the United States and New York



WAGONS—Typical Civil War wagons included: (1) limber; (2) mortar wagon; and (3) Barbette carriage for 24-pdr.

troops" — "We have sent 19,800 smooth-bore muskets and cannot fill Major Thornton's order for 2,000" —"New York State has taken 30,000 ball cartridges, being all we had on hand." "First come, first served" was the rule. Many orders were filled for General Wool himself until May 2, when Major Mordecai had the pleasure of informing the General that "In compliance with Special Order No. 120 from the Adjutant General's office, directing that issues of ordnance stores from the arsenals shall be made only on orders from the Ordnance Office. I find it necessary to suspend execution of your instructions rela-

tive to gun carriages until I can hear from that office. As for the harness, an order received today from the Ordnance Office calls for all the artillery harness on hand here and all that can be made this month."

On that same May 2, Lieutenant Porter returned from Washington with a refusal from the Ordnance Department to Major Mordecai's request to be relieved from the command of the Arsenal, forcing him to take the step which he dreaded. He replied: "I thank you for the complimentary terms of your letter but peculiar circumstances which it seems to me unnecessary to explain further, make it impossible for me to continue in the discharge of the duties of the commanding officer of this Arsenal. As your reply cuts off the hope of my being relieved from them, I have tendered the resignation of my commission in the army. Wishing to spare you unnecessary embarrassment, I inclose my letter of resignation to you in order that before presenting it, you may make arrangements for a successor in the command of this important post.

"After thirty-eight years of faithful service, I trust that I need not assure you that the public interests here will in the meantime be perfectly safe in my hands. But I hope that the interval before the arrival of my successor will be as brief as possible. It will be gratifying to me if a competent officer of suitable rank can be found to make a careful inspection of the Arsenal before I leave it." For the first time in thirty-eight years, his signature stood alone, not followed by his military rank and branch of service. Action was rapid following this. On May 14, he was presented with an authentic copy of a special order from the Adjutant General's office and relinquished the command to Major William A. Thornton. Torn between his loyalty to the Federal Government and his love of the South, Mordecai left the country and, during the remainder of the Civil War, directed the construction of a railroad in Mexico, running from the Gulf to the

Pacific Ocean.

Major Thornton was no stranger to Watervliet Arsenal, having been stationed at the Arsenal as an assistant to Colonel Talcott from 1833 to 1836 and during Colonel Worth's command had been assigned to temporary command a number of times. Again in 1858, under Major Mordecai himself, Thornton had been stationed at the Arsenal while he was preparing building materials for the Benicia Arsenal. As commanding officer of the New York Ordnance Depot, he had held an important and responsible position for three years, and was felt to be the logical choice for the new command. This logic was to prove to be keen indeed. The haste with which he had been ordered to Watervliet forced him to leave the New York Depot with much unfinished business so that temporary command was turned over to Lieutenant G. C. Strong until he had taken care of his "pressing duties." Lieutenant Strong's command of two weeks was marked by an order of two million percussion caps, the largest of its kind that had been sent from the Arsenal up to that time. This was considered an unusually large order for materiel. However, before the summer of 1861 had passed the Arsenal was ordering ten million caps at a time and complaining bitterly at the slow delivery. By November, the Arsenal workshops were using forty barrels of gunpowder a day, which was a tremendous jump over the orders in the spring.

By the last of June, Major Thornton realized that the funds furnished by Washington would not equal the costs of supplies ordered by Washington. He advised them that he needed at least $15,000 more than had been estimated for the quarter, pointing out the heavy and urgent demands being made on Watervliet Arsenal. His gentle request had no result and a month later he informed the Ordnance Department that "several accounts had to be suspended for want of money and, as we are daily increasing our debts, some of which demands should

have immediate payment, I hope a remittance will be made without delay to enable the paymaster to satisfy some of our wanting creditors." The funds did arrive, but in the form of Treasury notes instead of the gold which had previously been used, so that the creditors refused to accept them in payment for goods. Major Thornton again had to write: "I must be candid in this matter and report the embarrassment already caused by offering Treasury notes in payments. Yesterday I contracted for 3,000 pigs of Galena lead and today the contractor called and declined furnishing the lead if paid for in Treasury notes. I am using 10,000 pounds of lead a day and every hour is important. Further, a dealer has furnished lead to us for which he states that he had to pay cash at the mines. He obtained his means by a loan and today I offered him the Treasury notes in payment for the lead delivered. He declined accepting them because their discount command more than his profits in the sale. The bank is pressing him to refund the money borrowed and unless he answers the demand, his credit will be protested and consequently he will suffer a great wrong. The case must be promptly and squarely met. I must have specie to settle up dues or we will have to stop work for want of supplies.

"Our paymaster cannot dispose of these notes at their face value in payment of debts incurred. The discount on like notes was three percent in New York yesterday and persons in this neighborhood will not accept them this day short of four percent. We will do all in our power to dispose of the notes received, but we must have a remittance of specie for payrolls and to close back accounts."

By August nothing had been done about the situation and Major Thornton was still trying to press Treasury notes upon the creditors while seeking funds for payment for the laborers for the month of July. In September, having given up hopes of receiving gold from the government, he added the information to a

letter ordering supplies that Treasury notes "Might have to be accepted in payment," and as an added encouragement to creditors to accept the Treasury notes, Major Thornton began hinting that anyone who would not accept them was dishonoring the United States and icily informed one company that "should I have to pay in Treasury notes, I will not admit a discount on their face values. I have no desire to obtain your property at other than just rates, but I will not be a party to dishonor the credit of our country by depreciating the value of its notes, which are better than any bank security in the country." Even so, outstanding debts at the end of October amounted to "upwards of $80,000," and his correspondence turned to soothing notes in answer to the duns that fluttered thickly to the Arsenal gate — "I have received your kind note and in answer I have to say that if I had the funds the account would be immediately paid. You may depend on it that the account will be paid as soon as possible."

Finally, funds arrived in December, but the $98,000 received still left debts of some $50,000 and the Arsenal employees were not paid for December or January. The last day of January, Major Thornton reminded the Ordnance Department that not a dime of the last three requisitions to Congress had been received, but financial conditions grew even more desperate and Thornton's greatest worry was about "our destitute laborers — men, women, and children — who have now three months pay due them and who, day by day, are applying to me for money to obtain the actual necessaries of life, food, fuel, and clothing." The condition of the wants of the employees was becoming so urgent that he stated that work at the Arsenal might have to be suspended, but this too was problematic as many of the employees were "boarders in this neighborhood, and have not the means to pay their debts and return to their families."

At the end of April, the workers were actually paid,

after a final ironical incident. The sought-for amount arrived at the Arsenal in the middle of April made out in the name of the paymaster who had been changed in the long period between sums received, with the results that no one could endorse the Treasury draft — officially, the former paymaster could not and neither could the new. Thornton immediately wrote to the Ordnance Department, reminding them at the same time that "the wants of our workmen are such that every hour's delay is hazardous of a suspension of work at this Arsenal. There has been a public meeting and strike of many for wages." The check was endorsed by the former paymaster and on April 24th, a memorable date for the employees, they were paid their wages from the previous December.

Major Thornton's job was difficult, for not only was he troubled with financial problems, but the continually increasing needs of the soldiers for materiel strained the Arsenal to the limits of production. In the middle of July, 1861, Thornton stormily replied to the Chief of Ordnance's plea that the Arsenal employees work night and day, that they had been for the past two months, and announced emphatically: "I assure you there is no idleness here!" However, the employees could not overcome the lack of supplies, and as production increased beyond what they had believed would be possible, the Arsenal was "exceedingly pressed for supplies" and remained in that uncomfortable situation throughout the two and one-half years that Thornton was in command. Ammunition was the supply most in demand from the Arsenal and, since percussion caps were no longer made at Watervliet, one of Major Thornton's incessant duties became the urgent demanding of caps which were rapidly used in turning out cartridges. Only one month after he had left the New York Depot, he wrote back that he had been brought to a "dead standstill for want of caps when in the midst of heavy demands for cartridges." He

STRAPPING — Strapping spherical case shot.

had been advised two weeks before that they were forwarding 5,000,000, but none had been received. His letter was interspersed with such phrases as "do, for goodness sake, send some to me," or "do hasten them forward." He later contracted with a private manufacturer to supply additional percussion caps that could not be furnished by the arsenals, and by December of that year, orders for this commodity were for as many as 10,000,000 at a time, for which private manufacturers were paid eighty-five cents per thousand. St. Louis seemed to have had a monopoly on the manufacture of saddle trees at that time, and because of "the disturbed condition in Missourie" long delays were suffered for that necessary article which was needed to meet the enormous quota for saddles. The Arsenal was luckier, as far as gunpowder went, as a Schaghticoke, New York company was the main supplier and that plant worked to its greatest capacity from the day the Civil War began, although by September of that

FILLING SHELLS — Shells are filled with rosin.

year the thirty barrels of musket powder that they furnished per day was not sufficient. Other gunpowder makers began helping out, and by November the workshops were using forty barrels per day, while Major Thornton hoped to have enough powder stored in the magazines to last during the months that the Hudson and Erie Canal were closed to navigation.

With all the need for haste and the financial difficulties of the Arsenal, the commanding officer still insisted that "only the best could be sent for the use of the United States." To a company making gutta-percha buckets for the army, he wrote: "The government requires good work and it is for your interest not to send anything that will not pass a critical inspection and by its goodness do you credit." Efforts to hide defects in supplies infuriated Thornton; the more annoyed he became, the shorter his letters grew. To one maker of shot and shell he sent a one-sentence but completely informative letter: "I find some of your 18-pounder shot plugged and I have to inform you that any effort hereafter to conceal defects in shot or shell castings will cause the immediate suspension of orders from this Arsenal for such supplies." A neighboring Troy firm was informed that defects in shells filled with lead had been found and Major Thornton therefore declined to receive any more castings.

Prices were rising rapidly during this period, which Major Thornton sought to counteract by canceling orders or decreasing the amounts ordered. When the price of tarpaulins jumped two dollars, the order from the Arsenal dropped from 200 to 100, although later more had to be ordered at the higher price. The price of cotton cloth used to make cartridge bags jumped from thirty-three cents a yard to sixty cents within one month, resulting in the purchase of 30,000 yards of silk imported duty-free, as it was for the government, and which, of course, turned out to be an improvement over the cotton, since, as Major Thornton

put it, "it will not burn, it does not stretch, and moths won't eat it!" By the statement regarding burning, he undoubtedly referred to the property of silk of burning without leaving any ash, the whole cartridge bag being consumed in the operation, leaving no burning residue to heighten the danger of firing the gun. The most serious controversy occurred, however, with the lead speculators, with whom Major Thornton fought a word battle during the first year of the war. The story, in his own words, is detailed: "The lead dealers think to crowd the government in the purchase of lead and balls when there is no justifiable cause for any rise in the value of lead. The government is not using anything like the quantity of lead consumed before the war for the making of white lead paint. As there is not a great demand for paint, the present price of lead should not be above its cost before our present troubles. When I entered on my duties here, I was in want of lead as I found but a few tons on hand. I was beset by dealers to furnish at high prices because they said it was not in the market and that it would increase in value and I had better take it at their figures.

"I told them plainly they might go to 'Jim Crow' with their offers, that I would see the lead rot before I would give the price they demanded. My stock became exhausted and I had to borrow 120 pigs to keep at work until a small quantity I had purchased would reach me. A dealer promised to supply me with 5,000 pigs of lead at 5.15 cents a pound. It rose to 5.45 cents and he called to see if I would not let him drop the agreement. I told him instantly 'yes' and had no more to say to him. A few days later, he called to get a contract for some other articles. I told him we had closed all business transactions by the course he had taken in the lead agreement." His eyes were opened. He sent me the 5,000 pigs, and since which my stock has been on the increase at reasonable terms. I am now in the pursuit of 300 tons of soft German lead,

which I expect to secure delivered here at five cents a pound. I therefore beg you say nothing of my prospects and to touch the New York market gently." Eventually Thornton secured a shipload of German lead, duty-free, and the lead dealers did not try to "crowd" him again.

There were only four officers to assist the commanding officer with his various problems in 1861, in spite of Major Thornton's appeals for more, as men were needed in the field. Lt. Porter was ordered to active duty, although the Ordnance Department was informed that the commanding officer of Watervliet Arsenal was "laboring under tremendous pressure to meet the requirements, and in place of calling from me my assistants, I state on my honor that I need more help and I cannot but hope that you will not deprive me of those men on duty with me." In the spring of 1862, when requisitions were coming in so rapidly that it was difficult to plan, let alone fulfill, production, there was but "one young

MOULDING BULLETS — Arsenal production shop moulds and crates bullets for shipping.

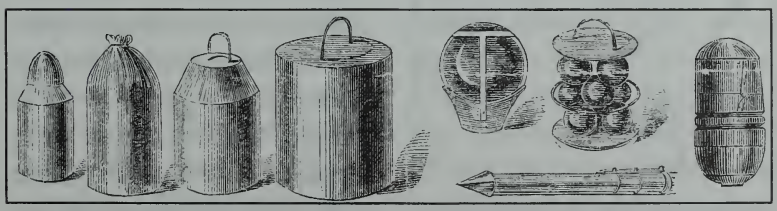
FILLING CANNISTER — Cannister shot is loaded and crated in Civil War production shop.

officer" at the post. The best trained enlisted men were also ordered into the field, against which Major Thornton ineffectively argued: "I have to report that a severer infliction cannot be made on this Arsenal than to detach from it its present enlisted men. They are needed not only for the protection of the vast amount of public property here, but they have experience and are our sure dependence. By their energy they give spirit to our laboratory service, and I most respectfully beg of the General (McClellan) not to cripple (the Arsenal) by calling from it our only experienced workmen in putting up fixed ammunition and other laboratory supplies.... It is but a few days since our shops were endangered by fire originating from constant work by day and night in molding leaden balls. We cannot for a moment omit the most rigid supervision, watchfulness and care for the due protection of the public property at this Arsenal. And I find no persons more to be depended on in the faithful discharge of their duties than our enlisted men. I trust that you will be

pleased to suspend the action of the order."

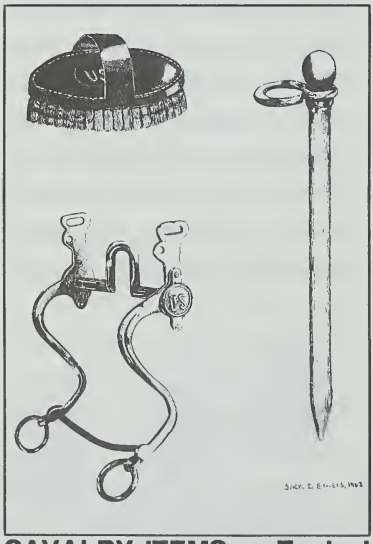
Troubles were also caused by the two elements — fire and water. Seven months after the war had begun, nine of the "hired citizens" were badly burned by an explosion which occurred in the greasing room where they were lubricating ball cartridges for Sharps Carbines. As the story goes, "the lubrick is melted in tin pans by means of oil lamps. The wick of one of the lamps by burning became coaled, and one of the persons injured removed the lamp from under the pan and carelessly struck off the coal on fire, which, falling into a box containing scraps of cartridges, produced the explosion," Major Thornton wearily explained that he had done everything in his power to impress the great need for "utmost care," but "however faithfully advices may be given, there are some who never think of the contingencies that may follow their neglect." Both the lack and surplus of water caused difficulty at the Arsenal. In the early winter of the first year of the war, the water in the canal got so low that it gave only half enough power and the machine work was stopped twice. The supplementary power supply, the old steam engine, was called into service but broke down from the overload. The Canal

Commissioners were told by Major Thornton that he was working nearly 1,000 employees and a quantity of machinery, and "hardly need say that the embarrassment caused by the non-supply of water from the canal is tell-



AMMUNITION — Various types of ammunition manufactured at Watervliet Arsenal.

ing heavily on our army supplies." In order to "meet the requirements of the government for our country's existence," Major Thornton pointed out that the water from the canal was necessary and the commissioners obliged by charging the Arsenal, for the first time, $1,000 to keep enough water in the canal during the winter to keep the Arsenal machinery going. When the post was flooded three feet deep in April 1862, the commanding officer reported that it was the first time the shop machines had been stopped in six months, "having worked days, nights, Sundays, and meal-hours without ceasing." Thornton and all the employees were working from 6:30 in the morning until 10:30 at night every day in the week!



CAVALRY ITEMS — Typical items manufactured for the cavalry.

Following the progress of the war with intense interest, the commanding officer fully realized the important part the Watervliet Arsenal supplies were playing in the conflict, perhaps because he was in close contact with those actually using the material. To one artillery Captain, Thornton promised that he was doing all in his power to answer his wants, that "the stores will follow (the battery) as quickly as is in my power to send them," and added fervently, "God grant that they may all reach you in time to do good." Not to be able to fill the orders immediately and completely was a personal disappointment to Major Thornton, and he once wrote the Chief of Ordnance regarding his inability to manufacture some cavalry bits because he lacked a

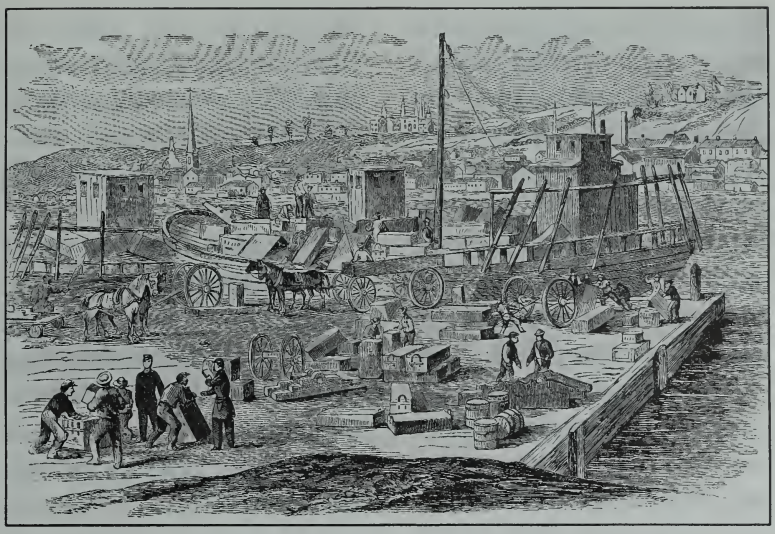
sample bit by which to work, saying: "It is exceedingly painful for me to be placed in my present position, for I detest nothing more than to report the inability of this Arsenal to meet any demand."

The demand was tremendous. Orders were received not only from the Ordnance Office, but also from other arsenals which were unable to fill the orders themselves. These were sometimes impossible to fill, much to Major Thornton's regret, as expressed in his replies — "I will do all I can to help you but as I have all I can well stagger under, let me be your last hope. Then all the means we have shall be put forward for your immediate aid." Once Thornton asked another arsenal to fill part of Watervliet's large order for gun carriages which were to be completed almost immediately, and when informed that it would take the other arsenal one month to complete ten carriages, ruefully replied: "I hope we will have the City of New Orleans before you can finish forty-seven carriages."

The need for rifles grew so great that American manufacturers could not meet the demand, and many rifles were purchased from Austria. Prussian rifles were duly tested at Watervliet, but were pronounced to be of poor workmanship and incapable of firing American ammunition, so that the plan to order some was abandoned. There were still 250 flint muskets stored in the Arsenal which had been manufactured in 1830, and these were dusted off, altered to percussion and distributed to the Union troops. Tremendous amounts of shot, shells and plates were ordered during this period, the principal makers of which were six iron foundries in Troy; Major Thornton divided each requisition from the Chief of Ordnance and ordered a few thousand from each foundry in order to insure quicker delivery. The material, to be delivered "with all possible dispatch at the Arsenal," was faithfully produced throughout the war — millions of pounds of projectiles — by Fuller Warren and Co., Swett Qimby and

Co., Starbuch and Bros., Knight, Harrison and Paine, Seymour and Watson, and Dr. Viele and Sons. The firms, by the time the war had entered it second year, were not paid in gold or treasury notes but with certificates of indebtedness of the United States "which may run not to exceed a year from date at six percent interest." A great deal of difficulty was experienced in keeping enough gun powder on hand — the Schaghticoke Powder Company which had always been the principal source of supply, lowered its standards to increase the quantity during the second year of war, until its powder could not meet the tests of the army inspector. Major Thornton characteristically decided that it would be better to send no ammunition instead of the poor product, so laboratory work at the Arsenal was stopped and many of the boys obtained work elsewhere. When powder was obtained some months later, new employees had to be trained, so that production did not pick up too rapidly. Just as the work was beginning to run more smoothly, the Arsenal's supply of paper, which was rolled into cylinders and formed the first step in making cartridges began to run low, and the Commanding Officer appealed to the patriotic side of the Ordnance purchasing officer, saying: "I am now in full blast of cartridge production, and my boys are working like Democrats. Send the cartridge paper; you must not give them a chance to become Copperheads!" During the second summer, moreover, the Ordnance Department ordered that every individual take an oath of allegiance to the United States, and two persons were discharged for declining to do so. At the same time the workmen at the Arsenal were exempted from the draft called that August to obtain 300,000 additional troops for nine months service, testifying to the importance of the work being performed at Watervliet.

When enough materials were collected to keep the cartridges rolling from the Arsenal, shipments of as

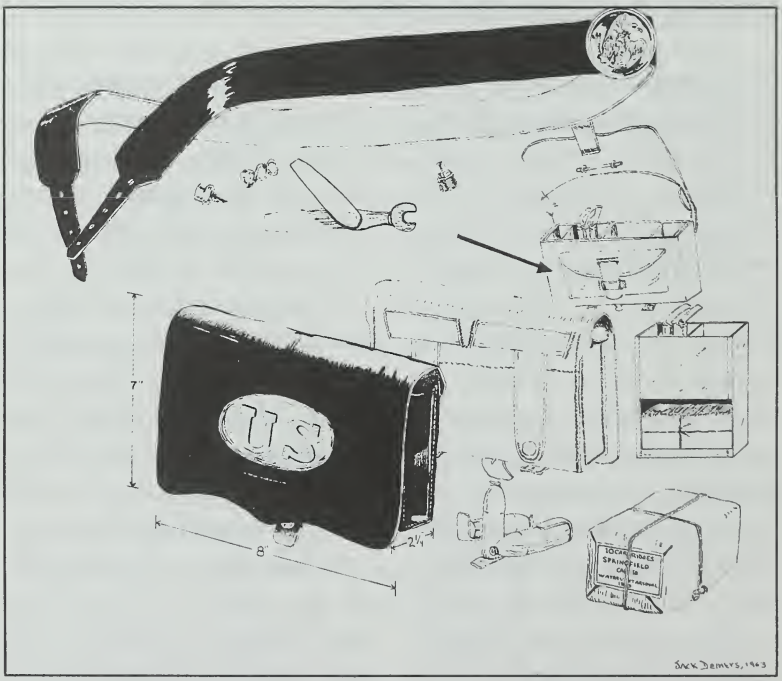


SHIPPING — The proximity of the Hudson River made for easy shipping of guns and ammunition.

many as 10,000,000 were sent at frequent intervals, some of which went directly to the battlefield accompanied by an agent. Normally the railroads refused to carry "fixed" ammunition — that which had the charge of powder attached to the projectile — but in times of emergency it was allowed if an agent, or guardian, accompanied the shipment, and in December 1862, Thornton's son, William A. Thornton, Jr., acted in this capacity to deliver 3,500,000 cartridges to Louisville. He received instructions similar to those issued to every agent, urging diligence to prevent any unnecessary delay, and ordered that, "as the property is very valuable and can be destroyed by an active enemy," it was to be guarded against the danger of capture as it approached Louisville. On April 30, 1862, Major Thornton had the satisfaction of proclaiming the heaviest day's work ever accomplished at the Arsenal and gave a detailed list of the material which had been shipped, pointing out that six of the wheels of the carriages forwarded had been made "in the brief time from

9 p.m. last evening to 3 p.m. today, the hour of shipment." One of the tremendous orders, which went to Lieutenant Baylor, Fort Monroe Arsenal, consisted of ten 18-pounder siege carriages complete with implements and equipments for 30-pounder rifle guns; thirty-three drag ropes; 5 men's harnesses; eighty 8-inch carcasses; six hundred 10-pounder canister; rifled and filled; forty 12-pounder shot fixed for light guns; three hundred and sixty 12-pounder cases fixed for light guns; and six hundred and eight 12-pounder shells.

Various other unusual items were also on the list for production at the Arsenal, all of which received the same attention as the more important shells and gun carriages and were up to the same high standards set by Major

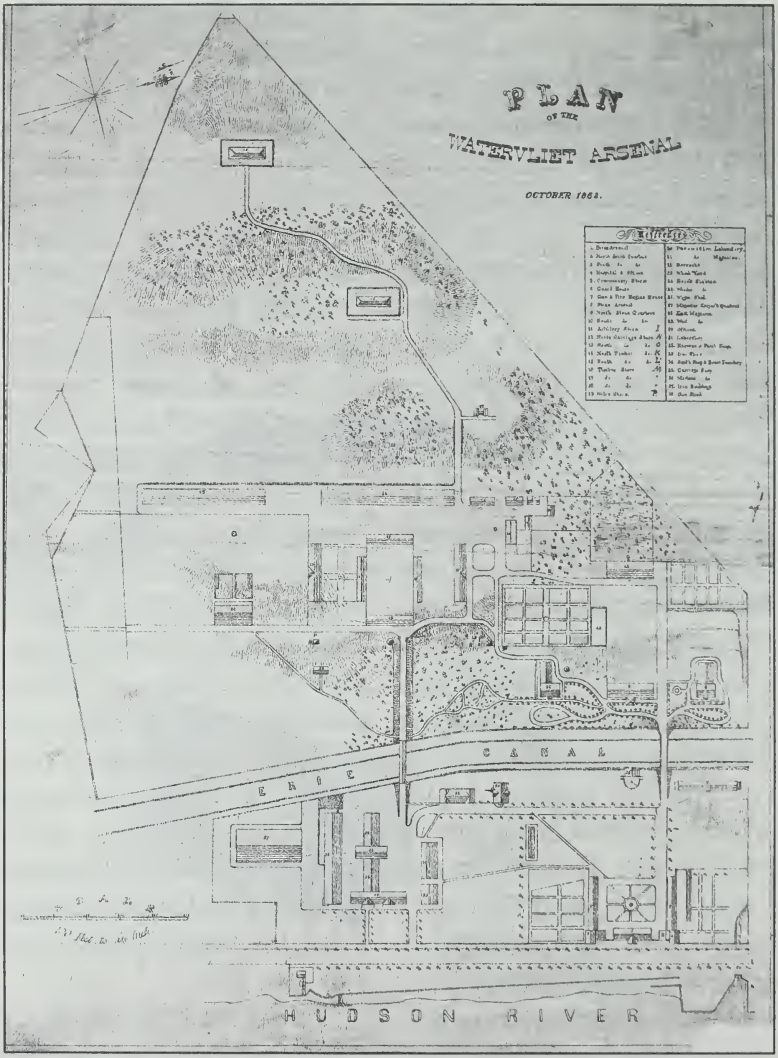


LEATHER GOODS—Arsenal supplied cartridge box shoulder sling, rifle accessories and the cartridge box itself holding 40 rounds for Civil War soldiers.

Thornton. So many infantry leather accoutrements were wanted at one time that lots of 20,000 were contracted to Troy leather companies. Such work was new to them, however, and the workmanship was so poor that thousands of the waist belts, scabbards, cap pouches, and cartridge boxes were rejected by the Arsenal. Another order appeared for lariats, a product with which Major Thornton was thoroughly familiar, having been stationed at an army post in New Mexico for four years where he learned the necessity of a good lariat for a horseman, and he became particularly indignant when he was furnished poor rope to make into lariats. He explained in full the need for pure Italian hemp, or the next best substitute, instead of the compound of hemp and tow which he received, very poorly put together and "starched or sized" for the sake of appearance. Seethingly, he pointed out that "such rope has no endurance, it absorbs moisture like a sponge and when so filled it adds weight to the horse's load on a march (a horse has full enough to carry; by actual weight I found it to be on an average of 276 pounds, which test I made while in Mexico). Worst of all, as the lariat is coiled up when the horse is traveling, it retains the moisture it has absorbed from the dew or rain and rapidly rots and soon becomes unsafe to picket the animal. I assure you if I were to cut it into lariats I would feel as if giving to 'our army cause for the loss of many horses." Horses seemed to be Major Thornton's vulnerable spot. Another item made in the shops was nose bags — the small, round sacks from which the animals eat — and, for a time, five hundred duck cloth and leather nosebags were manufactured each day. Finally a field officer complained that those made at Watervliet were worn out in ten days, to which Thornton retaliated with the suggestion that they be made of wrought iron.

All during the spring of 1863, the Watervliet Arsenal was trying to produce 10,000,000 cartridges beyond

current orders so that night work might be stopped, but the orders were so large and frequent that there was never the surplus desired. In February, Major Thornton had reported that the Arsenal had furnished 30,000,000 hand-



1863 MAP — By 1863, the arsenal had grown into a large-scale production facility to support the war effort.

made cartridges, during which month they were only able to work "one-third time" for want of powder. The commanding officer checked the progress of work, making a tour of the workshops three times daily — he was extremely proud of the organization as a whole and "believed that better and quicker work could not be produced in any other establishment in our country." By June the peak of intensity of work was reached, Major Thornton had been made a Lt. Colonel, the Southern armies were moving north, and it was feared that Washington might be surrounded or captured. The Chief of Ordnance instructed the Arsenal on June 15 that, "in case of telegraphic communication being interrupted between us, fill the requests of the commanding officer of the Department of Monongahela and Susquehanna." At the same time, it was ordered that 3,000,000 pounds of nitre and 400,000 pounds of sulphur be taken from the Frankford Arsenal in Pennsylvania and shipped immediately to Watervliet for safekeeping and storage. Watervliet's storehouses were already overcrowded; there were more than 20,000,000 pounds of lead on hand at the time, and the arrival of more stores necessitated sending portions of the nitre and sulphur to the Rome and Vergennes Arsenals. The arsenals at Vergennes, Vermont, and Rome, New York, which had been under the supervision of the commanding officer of the Watervliet Arsenal since its founding, had not been used for any purpose for many years before the war. The government had made efforts to sell them for ten years, but had received such low offers that nothing had been accomplished. With the advent of the Civil War, they again became useful, were repaired and staffed and used to store thousands of pounds of material — the men in charge of these arsenals were responsible to Colonel Thornton, who made a number of trips of inspection during the war.

That summer was one of continued intensive activity. The year of 1863 saw the

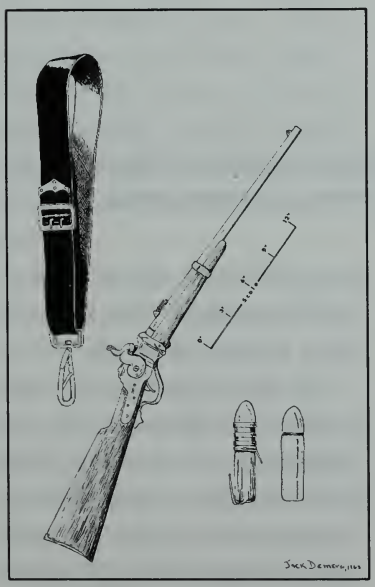
greatest successes — Gettysburg, Vicksburg, Chattanooga — as well as the heaviest reverses — Chancellorsville and Chickamauga — for the Union Army. On the Fourth of July, they emerged at last with a decisive victory after the tremendous three-day battle at Gettysburg, Pennsylvania. Even the smallest child working in the Arsenal could realize the part played by ammunition and supplies pouring out daily from the post to the battlefields. Every employee exerted himself to the utmost degree. The private manufacturers in the vicinity contributed to the effort to the best of their ability, sending in hundreds of thousands of pounds of shot and shell to be made into cannon ammunition. The delivery was held up only once, and that by a riot that was in progress in Troy, "rendering it imprudent to send the stores there for shipment."

In December, Thornton was promoted to the rank of full Colonel, and on Christmas Day left the Arsenal to assume the duties of inspector of contract Arms and Ordnance. He had seen the Arsenal through the better part of the war, had established a fine record for himself and for the Arsenal, and left the establishment in excellent shape for the next commanding officer to step right in and go on with production. In the last year of the war, Colonel Thornton was promoted to the rank of Brigadier General, signifying his worth to the Ordnance Department, and shortly after the war his career ended with death.

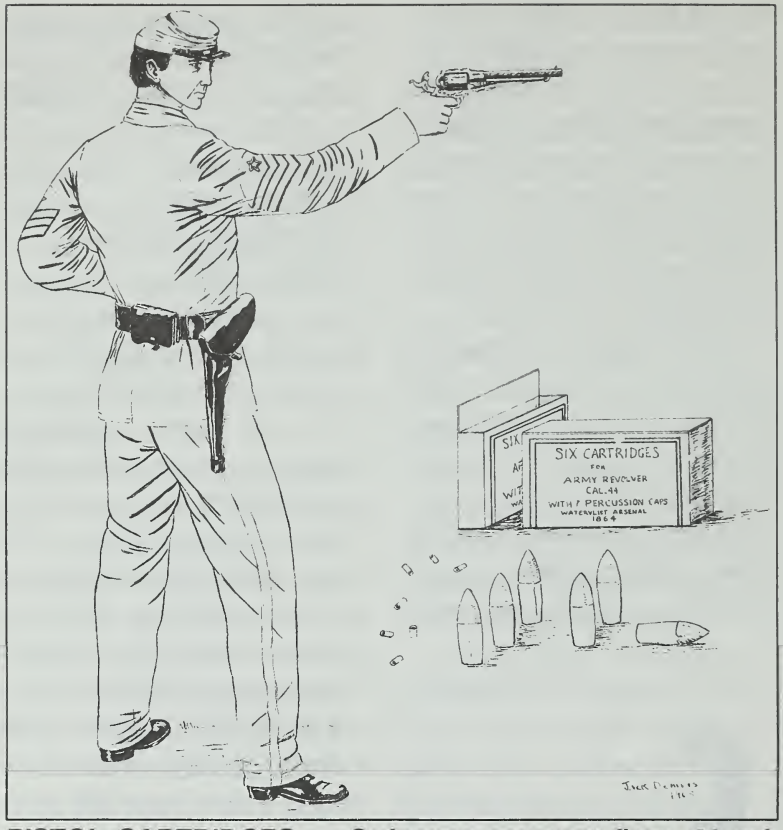
Peter Valentine Hagner, Lieutenant Colonel of Ordnance, who assumed command that Christmas Day, held the command for seventeen years, the longest period that any one man held the position at the Watervliet Arsenal. A veteran of the Florida and Mexican Wars, having been wounded in the battle to capture Mexico City, Colonel Hagner had also commanded various other depots and arsenals so that he had an excellent background to aid him in taking over Colonel Thornton's command. Al-

though the Civil War continued for a year and a half after Colonel Hagner's arrival, the worst production problems had been solved, and the peak of production had been reached beforehand. The tools were there, the employees skilled in their use.

The highest number of employees during the Civil War totaled about 2,000 one-fourth of whom were children. Earlier in the war only boys had been hired, but girls were working at the Arsenal in 1864, and both were employed in making cartridges. The first step in the job was to roll paper cylinders, at which the males were found to be quite dexterous. However, in 1864 a heavier cartridge for the Sharps Carbine was in demand, and linen was found to be necessary instead of paper for the cylinder. "Boys such as could succeed pretty well with paper cartridges failed to make the linen ones good enough to please me," wrote Colonel Hagner. "I had to turn out the saddlers in the low buildings near the gate and start girls in those rooms making cylinders, having them filled and the balls inserted by boys in the laboratory. I now have 225 girls there employed and nearly a full force of boys in the laboratory." One of these 225, Miss Elizabeth Owens, described her personal experiences to Brigadier General A. G. Gillespie, Commanding Officer of the Arsenal during the Second World War, when he called on the 90 year-old former employee in 1942. She recalled that her father had worked at the Arsenal making wheels — of



CARBINE — Leather slings and paper and linen carbine cartridges were made.



PISTOL CARTRIDGES — Ordnance sergeant fires .44 cal. Remington revolver using arsenal-made ammunition.

wood — for cannon but had worked longer hours than she, and said, "I was nine years old and all of us little girls sat on a long bench, our feet not quite touching the floor, and we filled cartridges all day long. When we finished one we'd put a little glue on the end of it and fasten it in a box set there for us. I worked from seven in the morning until six at night." Mr. Owens often worked until ten.

A new laboratory was planned by Colonel Hagner, one which was to be detached from the cannon ammunition laboratories, "under the eye of the commanding officer at his office," and "in this part of the grounds so that the 500

or 600 children usually employed may be kept away from all other shops and have a convenient and special entrance upon the main road." In addition to the children, a few women were employed at the Arsenal, although many more turned out products in their own homes for the shops. One supply made almost exclusively in homes was cartridge bags. A woman was expected to be able to sew 100 cartridge bags for 6-pounder cannon in twelve hours. This type of work was given to "the poor and needy of the neighborhood," with particular care being taken that none received it but those who actually needed it and that those who did need it received it "in like proportion."

One female manufacturer did business with the Watervliet Arsenal during the war, also. Miss Mary Patterson of Lansingburgh had a small factory for making horsebrushes, and Colonel Thornton had said in recommending her work to the Ordnance Department, "She is the only honest brush maker I know of in this vicinity!" She had contracts to make 35,000 brushes in 1864 at five dollars a dozen, with the provision that she furnish 1,000 per week. She seems to have appealed to Colonel Thornton's successor also, as the government was slow in paying for the last 20,000 brushes, and Colonel Hagner recommended to the Chief of Ordnance that she be paid promptly, "as the lady is in very delicate health." One month after she received payment, her health had so improved that she sought another contract for 10,000 brushes. Her work must have been completely satisfactory, however, and since this seems to be the one and only accoutrement for a horse during the Civil War with which Colonel Thornton had no trouble, he was undoubtedly doubly pleased.

The enlisted men stationed at the Arsenal in 1864 numbered forty-five, with two subalterns in command, and Colonel Hagner thought that the amount of work necessitated one hundred men headed by five subalterns. In

November, he believed that his wishes had been granted. Two officers and 104 enlisted men arrived, followed three days later by seventeen officers and 312 men of the 98th New York Volunteers — all encamped on the Arsenal grounds. Happily, he gave the new soldiers "special guardianship of our boundaries" and began hastily to erect wooden barracks. Two weeks later, without notice to Colonel Hagner, all the soldiers were ordered to other stations. The regular detachment of enlisted men were remembered when plans for new buildings were made in the spring. Concerning the living arrangements on the post, Colonel Hagner wrote: "We now have the First Sergeant and two others with their families in the barracks, four men with their families near the gate, besides the hospital steward, and five married men living outside. To accommodate all, after the houses at the gate are removed, and to make room enough in the barracks for our full force, we should have cottages sufficient for eleven families, besides the present cottages now occupied by two enlisted men. I am aware that the number of married men here is unusually large but they are all old Ordnance men long stationed here and very good and useful men, exercising a good influence over the unmarried soldiers."

The overcrowding of all the buildings was one of the most pressing problems that met Colonel Hagner when he arrived at the Watervliet Arsenal. He immediately urged that some of the stores be moved, as he found the "stone Arsenal is much overloaded. The window sills of the main story are nearly all cracked and the floor has settled in the center." There were 20,000,000 small arms cartridges on hand, over a million of each kind likely to be issued, and 9,000,000 of caliber .58. In one timber shed alone, which was "distant from protection and not suitable for such stores," there were 18,000 muskets stored, and Colonel Hagner wanted to reduce this to about 10,000. The stone arsenal, only a few yards from the commanding

officer's quarters, contained 14,000,000 cartridges in company with the Arsenal's most valuable stores.

Instead of ridding the Arsenal of stores, it now became necessary to increase the storage space. Soldiers were being mustered out of the army and their equipment had to be sent to the Governments Arsenals for storage. In March 1864, the Ordnance Department inquired about additional storage space. Colonel Hagner replied: "I can make storage for 50,000 muskets in Shed K by removing some battery wagons and siege carriages. I can store 20,000 more in boxes on the second floor of the stone arsenal and 28,000 in the racks on the first floor. This first floor has been full of ammunition, which I hope to get rid of, as I consider it proper to exclude ammunition from that building and, especially, to relieve that floor which has been greatly strained and floor beams crushed by having them overloaded last summer. The racks full of muskets would not injure it and I propose placing in them all the old arms as they arrive. I might fill in between the racks with new arms in boxes, probably to the number of 25,000 more. I would, therefore, name 125,000 arms, including those to be delivered by contractors, as the maximum number in addition to the present supply." On hand also were almost 5,000,000 pounds of nitre, not counting the tons shipped to the Rome Arsenal, and by August the amount of lead stored was 17,500,000 pounds.

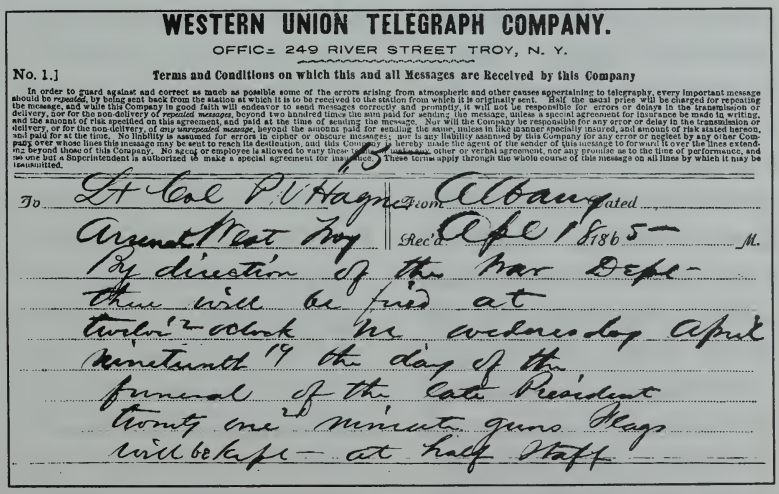
The machinery used in the Arsenal was now beginning to wear out, after the strenuous years of war. The boiler on the steam engine was the first to become completely unserviceable. It had been bought in 1848 for $800 and was sold, after fifteen years of use, for $300. A complete new steam engine was ordered from a Troy concern, and a new fire engine was bought at the same time since the old hand engine and force pump which had been in use had given a miserable performance when a fire began in the smith shop, spread

to the shed in which lead for the ball presses and sulphur for filling spherical case-shot were melted, and did not end in complete destruction only because the East Troy steam fire engines arrived in time. After such a demonstration of the superiority of the steam engine, Colonel Hagner realized the need of a similar engine for the Arsenal itself. To be certain that the new engine would have plenty of water to pump, Colonel Hagner requested that the water supply be improved. Writing in June 1864, he said, "I urgently recommend the construction of cisterns to garner up the rain water from the roofs. There is no such cistern near the shops nor the whole command during working hours. Hired and resident workers alike are dependent on the well and cistern near the old brick arsenal, neither of them of great capacity. On the west side of the canal, cisterns have been built to some of the roofs but not to the larger portion, and as well water is very limited and too hard for domestic use, a dry season like the present leaves us much inconvenienced for water, although we have sufficient roof surface, now lost, to secure an abundant supply. I urgently request authority to build four cisterns on the west side of the canal and one at the shops. In case of fire near the timber sheds, we must depend exclusively on cisterns for water."

Repairs were also needed for the Arsenal buildings — the stone arsenal was not the only one in a dilapidated condition. A program of renovation was started during the last year of the war and continued for two years after the war had ended, during which time a number of new buildings were also erected. The old percussion building laboratory was greatly altered in 1864 and was converted into the post hospital — its isolated position at that time was an advantage in securing quiet for the patients. New extensions were made to the Broadway Shops, which were remodeled into one connecting building. Colonel Hagner was opposed to scattering buildings because it was expen-

sive to keep the unpaved roads in a passable condition in wet weather, as heavy loads carried in the Arsenal wagons cut the roads into great ruts under even the best conditions. However, the Ordnance Department did not grant permission to the commanding officer's request to pave the post roads at that time. Plans for another wing to be added to the Broadway Shops were also made in the early part of 1865, but were never completed.

On April 8, 1865, General Robert E. Lee surrendered, and on the following day laid down his arms at Appomattox Court House. The formal close of the Civil War was made on May 29, 1865. On April 18, the Arsenal had received a telegram from the War Department saying, "There will be fired at twelve o'clock Wednesday, April 19, the day of the funeral of the late President Abraham Lincoln, twenty-one minute guns. Flags will be kept at half staff and labor suspended during the day." Three days later Colonel Hagner was ordered to Washington to confer with the Chief of Ordnance "on the



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To Lt Col P. V. Hagner — From Albany — Dated

Arsenal West Troy — Rec'd Apl 18 1865 — M.

By direction of the War Dept — there will be fired at twelve o'clock Wednesday April nineteenth 19th day of the funeral of the late President twenty one minute guns Flags will be kept at half staff

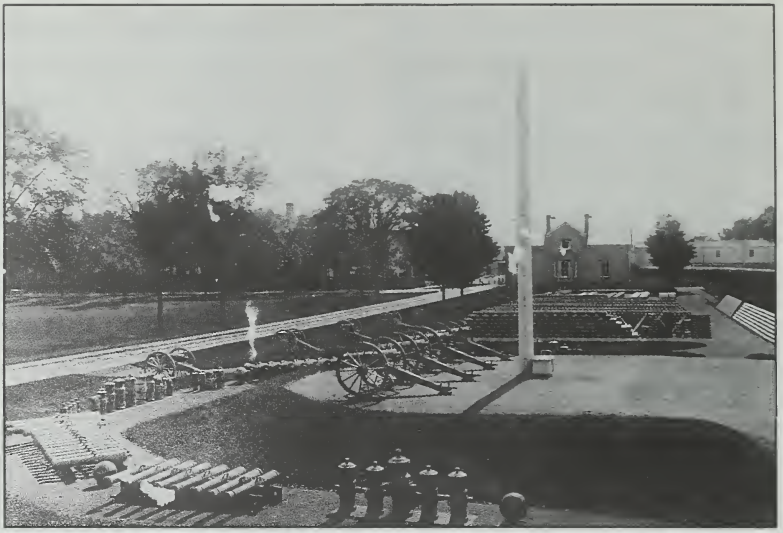
LINCOLN 'S FUNERAL — Arsenal receives orders to fire "twenty-one minute guns" and fly flags at half staff for funeral of President Abraham Lincoln.

subject of contemplated improvements in regard to reduction of manufacturing operations of Watervliet Arsenal." War, the cause of the unremitting activity at Watervliet, had ceased; with peace, a more normal pace could be assumed.

The third major war in which the Arsenal had been an integral part of supplying the armed forces found the United States, with the passing of the "struggle between the states," in a quite different position as a nation than at the beginning of that conflict; its international relations were changed to a much greater degree than were its domestic affairs. Better means and methods for national defense were required, and steps were taken to formulate and carry out a policy for such defense. With the rapid growth of world trade and the launching by the United States of a definite naval program, our Federal Government, in the last quarter of that century, found it necessary to improve its program for the production and maintenance of more modern weapons for military defense and warfare. The Watervliet Arsenal was to play a prominent part in this scheme.

Chapter 5
The Lean Years

From the Civil War until 1883, when the Watervliet Arsenal was converted into a cannon factory, the post's main function turned to that of storage rather than production. As early as 1863, small arms in large quantities had been returned to the Arsenal for storage and repairs and, with the actual ending of war, stores of all kinds began pouring in — ammunition, cannon, and small arms arrived in thousands and thousands of boxes, frequently in poor condition, and by the autumn of 1866 the storage space was almost exhausted. Makeshift store-houses were used. One flimsy timber shed was filled with 67,000 rounds of cannon ammunition crammed in with timber, muskets, harness, and other supplies, and the commanding officer was overwhelmed that autumn when notice was received that 12,838,550 rounds of small arms ammunition and 18,232 rounds of cannon ammunition were being shipped to the arsenal from Hilton Head, South Carolina, and Galveston, Texas. He protested violently that "such a shipment could not be stored at Watervliet Arsenal" and begged that it might be "di-



STORAGE — Tons of materiel were shipped to the arsenal for storage after the Civil War.

verted at New York and stored somewhere else."

Hagner had been brevetted a Brigadier General at the end of the war for his faithful service, and now found that he was busy enough to merit a promotion on the basis of his postwar activities! For the first time, his quarterly property reports to the Ordnance Department were late, for which delay he blamed "the immense mass of stores received, the non-arrival of invoices and receipts, and the great increase of work consequent thereupon supplying certified copies, proceedings of boards of survey, assorting stores for inventory, and also the large amount of extra work required by the Ordnance Office, all of which had to be prepared by clerks usually employed upon the property returns and who could not be replaced temporarily by inexperienced men advantageously." A few months after this, the Ordnance Storekeeper of the Arsenal literally went out of his mind, supposedly from overwork, and four officers were required to accompany him safely to the army asylum.

Guarding the valuable supplies which were scattered over the Arsenal Grounds in temporary storehouses, necessitated the assignment of 110 soldiers to the post. However, a year after the war had ended, there was a peculiar restlessness among the enlisted men and a number deserted. At the same time, a great many men who had served in the army during the war wanted to enlist again so that there was a rapid turnover of personnel but not a drastic shortage of manpower. By the spring of 1867, promotions for the men had come almost to a complete halt, which probably was one cause for discontent. The difficulty experienced in advancing one man from the rank of Private, First Class, to Corporal, is exemplified by General Hagner's recommendation: "This man is one of the earliest enlisted and best men; he has charge of the bakery, mess, and cookroom, company storeroom, gas and water pipes, securing economy and system in the use of these items so liable to wastage, and also strict police and attention to duties on the part of the cooks. To insure to him suitable authority and as a reward for his valuable and faithful services, he should have the rank of corporal as well as the pay of that grade." The man was one of the few to be promoted at the Arsenal in the years following the war, although his duties would seem to merit the rank of a Junior Officer at least. Punishments meted out to soldiers were reminiscent of Major Dalliba's command — harsh, by modern standards. For minor misdemeanors an enlisted man might receive a sentence which included withholding of his pay, confinement each night, and hard labor during the day while wearing a ball and chain. Sometimes a diet of bread and water for a few days was added as further punishment.

Although production in the Arsenal workshops was almost at a standstill — mainly consisting of repair to gun carriages — the Arsenal itself was not thrust into the background quite so completely as such a change would

indicate. European army officers came to inspect and copy our arms and ammunition, and the Watervliet Arsenal bullet press was considered the most impressive development in ordnance production by the visiting officers. France ordered one, to be made by a private manufacturer, and inspected by General Hagner before it was shipped abroad. The Arsenal, itself, touched on European affairs in 1870 when large quantities of Fenian arms and ammunition were seized by the United States and stored on the post until they were sold at auction. When the Fenian Brotherhood — an organization consisting mainly of Irishmen and with the aim of overthrowing the English rule in Ireland — made a raid on Canada across the Vermont border, the United States took firm measures and the organization ceased to be prominent after that time. Other stock was sold at auction, also-condemned stores, small arms, ammunition-and many of the old brass cannon, some of which were relics of the War of 1812, were sold for scrap. The principal buyer of the latter was the Meneely Bell Company of West Troy, which melted the cannon and cast church bells.

Reduction of supplies was continued during the 1870's by sales and issues, the money from such sales being welcomed by the War Department. In October 1870, there were 45,000 pounds of gun powder sold, while 30,000 rifles were issued to the New York Ordnance Agency. The small arms cartridges in the storehouses totaled only 6,500,000 rounds at that time. Some of the supplies, however, were difficult to move — 1,500,000 pounds of remelted lead on hand in 1873, and 1,500,000 feet of gun carriage timber. Such stores were the lifeblood of Watervliet Arsenal later.

A number of buildings were erected at the close of the war, although many were temporary, built of wood. All of the buildings in the original square were demolished in 1867 except the brick arsenal. Quarters 4 and 5 had been completed that year, as

ENLISTED QUARTERS — New enlisted men's quarters were constructed in 1867.

well as the new cottages for enlisted men and the octagonal guardhouse, and the old buildings were no longer necessary. Because of the great need for storage space, the brick arsenal was left standing until 1881, when it, too, was demolished. Extensive repairs were made in 1869 to the stone arsenal, which was in use until 1889. A new river wall and landing wharf were constructed in 1866 and a new main gateway was erected in 1869 to remain until 1941. The main roads on the post were paved in 1871 and the Horse Railroad Company, whose tracks ran along the public road in front of the Arsenal was altering its railbed in 1866, and offered to share with the Arsenal the expense of putting a good stone pavement on the five hundred yards of road crossing the post grounds. However, the plan was abandoned due to the lack of necessary funds which the Ordnance Department failed to advance. A group of lots adjoining the southeastern corner of the Arsenal grounds was purchased in 1866, after

almost two years of negotiation with the various owners and, during the following three years, a few more lots in the same location were bought and kept vacant as protection for the Broadway Shops.

In 1870, the army was reorganized and General Hagner returned to the rank of Colonel. At the same time the number of enlisted men allotted to the Arsenal dropped to thirty-five, and a large group of hired workmen were discharged. The following years brought forth further declines — the Panic of 1873 was followed by five years of economic depression throughout the nation. The Rome and Vergennes Arsenals were sold. Funds allotted to the army were so low that exceedingly stringent economy was ordered in all branches of the service. Most stringent of all, the House of Representatives proposed the sale of the largest army arsenal — the Watervliet Arsenal.

Colonel Hagner's report on the Arsenal in relation to the planned sale paints an excellent portrait of the post in 1874:

OCTAGONAL —The distinctively handsome octagonal guardhouse was build during this period of construction.

"I have received your letter asking for information relative to the value and extent of the United States property at Watervliet Arsenal 'considered as an addition to West Troy,' and my opinion as to the prospect of an advantageous sale should the Arsenal grounds be laid off into lots, premising that there has been recently no very active estimate of the value of the lots is based upon a few instances of the sales of single lots and may not therefore prove very accurate. First, the Arsenal reservation now contains about 109 acres and its character for all city purposes is equal and probably superior in the lay of the land to any area of like extent in the village limits. As in all the valley adjacent, a thin layer of soil covers a formation of slate rock of undetermined depth which affords the best foundation for buildings.

"The river front, 1,375 feet long, is faced by a substantial river wall at about low water mark for 575 feet, and for 800 feet with a new stone wharf affording about eight or ten feet depth of water, as much as can be depended upon above Albany. The average height of the wharf is nine feet above low water mark, the surface thence slopes to the level of the Albany Road nineteen feet above and at the foot of the wall east of the Erie Canal, twenty-four feet above; then, gradually until the highest point is reached sixty feet above, at about 2400 feet from the Hudson River. From this point, there is a gentle fall of about twenty-five feet to the western boundary 3,300 feet from the river.

MAIN GATE — Main entrance to the arsenal.

"Second, the reservation laid out into lots 120 feet by 50 feet, deducting streets, should be worth about

$400,000, excluding buildings.

"Third, the permanent buildings are numerous, valuable, and in excellent condition. They could in great part be retained, no doubt, as dwellings, stores, or factories. The inventory value of all buildings, bridges, enclosing walls and culverts is $841,000.

"Fourth, at present West Troy is chiefly a lumber mart and has no important manufacturing interests demanding increased space. No doubt, after the completion of the bridge at Congress Street in Troy, the growth will be more rapid and should this Arsenal be put into market for sale, a large increase of the manufacturing business now spreading through Troy would seek this side of the river.

"In conclusion, permit me to say that it should be remembered however valuable this site may be for private purposes, the like reasons make it especially valuable for the government uses. From our earliest history this valley has been a military highway and, until we possess Canada and the Valley of the St. Lawrence, this very Arsenal is the head of navigation, and the focus of all the northern, eastern, and

RIVER VIEW — A pastoral view of the arsenal from the Troy side of the Hudson River.

western transportation routes must be near to or on the way from the main manufactory of our military supplies. If, for any reason, another point offers superior local advantages for manufacturing, the present facilities of transportation make it admissible to seek such a point. But, as far as I am able to judge, there is none other superior to this. Lumber, coal, iron steel, concentrate here at the least expense to the producer and, for some reason this has been for many years the best market for labor other in quantity and variety.

"It will be seen by examination that military suppliers have furnished from this point as abundantly, cheaply and quickly as could be done from any point. This neighborhood rivals other manufacturing centers in supplying the market with an unusual variety of products of mechanical labor. To establish such an arsenal with like facilities would prove a labor of years and, when completed, can it possibly afford greater advantages for manufacture or supply?

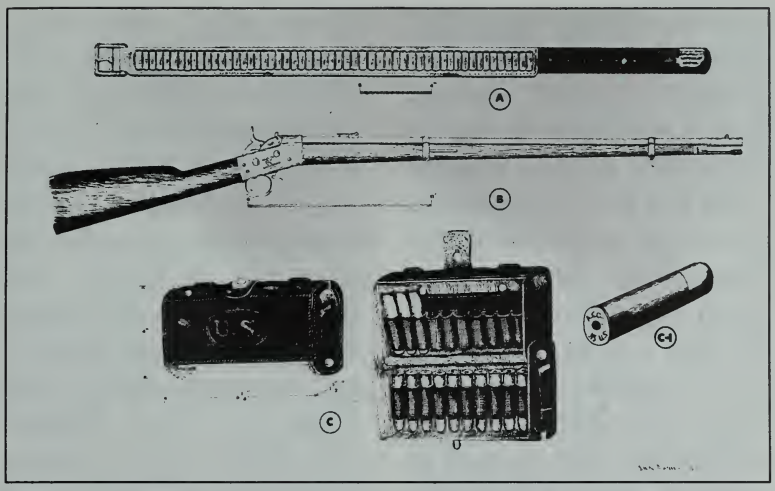
"If I have been guilty of carrying the discussion of the probable 'advantages of the sale of this Arsenal' beyond the points you have desired of me, I beg that you will excuse me in the warm interest this matter must excite in an old Ordnance officer."

Colonel Hagner added that if the Arsenal were not sold, he hoped that land could be bought on the western boundary connecting with the Delaware and Hudson Railroad, distant about 500 feet. In discussing this, he said: "The Arsenal has been heretofore used not merely for mechanical construction, but also for the storage of powder and ammunition, and about one-third of its area has been devoted to the isolation and protection of its magazines. If it is definitely decided to remove all powder to a special depository, the whole enclosed space here may be considered available for manufacturing purposes."

Eloquent though the pleas of Colonel Hagner were, they were ignored in Congress and until 1878 bills were pending to sell Watervliet Arsenal, as

well as five other arsenals including Watertown. Congressmen were especially in favor of selling Watervliet, because it was the most expensive to operate, and cost the Government $27,024.97 in 1877! However, the "For Sale" sign was removed from the Watervliet Arsenal, aided, undoubtedly, by Brigadier General Stephen Vincent Benet's letter to Congress in 1878. Benet, then Chief of Ordnance, said: "The provisions of this bill, should it become law, cannot be carried out unless Congress supplements them by making a large appropriation for, or by allowing the proceeds of this sale to be used in establishing a new arsenal, or in enlarging those retained, as recommended by the board. The arsenals to be retained have neither the working more the storage capacity necessary. The immense quantity of property in the arsenals named in the bill, of which Watervliet is the largest, must be stored away and cared for before any disposition can be made of them, or indeed before they can be prepared for sale; and the retained arsenals have not the capacity to receive these stores. Storehouses must be provided in advance and workshops must be enlarged. None of these arsenals should be sold." A bill to sell the other five arsenals was passed by the House of Representatives in 1884, but no further action was taken.

Even though Watervliet was not abolished, it had a hard struggle to keep operating and was harassed by financial difficulties for many years. In a later letter, General Benet observed: "It is the evident desire of Congress to reduce the number of ordnance establishments as shown by the inadequate appropriations made for several years for their repair and preservation." Production in the Arsenal shops was limited to filling small orders for infantry and cavalry accoutrements — haversacks, cartridge belts, saddles, harness — which were issued for replacements to troops in the regular camps, and to those in western forts where Indian uprisings were being dealt



SMALL ITEMS — Arsenal work was now limited to filling small orders for infantry and cavalry troop items.

with by the armed forces — Fort Sully, Dakota Territory; Fort Russell, Wyoming Territory; and Fort Dodge, Kansas. Workmen were hired only to fill orders and were dismissed when the job was completed. Many of the shops were closed for long periods because of this. The pay for those who did work was low — an average of about $2.61 per day for a good saddle maker — and the force of enlisted men was down to twenty-seven. Economic conditions throughout the country were disturbed, and a violent strike of railroad workers in West Albany resulted in a detachment of fifty Marines being sent to the Arsenal for two weeks in 1877 in order to protect the government property.

From 1877 to 1880 every penny received for operating the Arsenal had to be requested, and an exhaustive and detailed explanation for any expenditure was necessary. When the ammunition laboratory in the RW Building exploded in 1877, a third of the building was blown into the air and, for the sake of economy, the remaining two-thirds was repaired. New machinery was impossible to obtain, even though it was

needed, in some cases, to fill the orders received from the Chief of Ordnance. Instead, it was necessary to inquire from other arsenals whether there was any such machine not in use, and available for borrowing. At one time, when the Arsenal received an order with the request that it be completed within a very short time, Colonel Hagner ordered the men to work at night-the lack of machines necessitated longer hours, but he was later denounced by the Ordnance Department, because the work by gas light had increased the gas bill beyond his original estimate made months earlier.

Every means of saving was tried. Ammunition not likely to be used was broken up, the powder from the cartridges was sold, and brass was melted and used in the manufacture of various infantry and cavalry equipment so that no new metal needed to be bought. The money from the sale of the powder was used to pay for such machinery as a new industrial sewing machine for sewing haversacks and canteen covers, and "to introduce a telephone line from the workshops to the office." By one bit of ingenuity, Colonel Hagner estimated that he had saved $10,000. Horse brushes were ordered by the thousands, so Hagner used the lids of outmoded leather cartridge boxes as brush backs and sold the remainder of the boxes as scrap leather. "Doubtful" friction primers left from the Civil War were issued to posts for firing the sunrise and sunset guns, with the idea that if one primer did not set off the entire salute, they had time to try another! All the modern arms that had been stored at the Arsenal were either issued or sold, and none remained by 1880. The vacant brick arsenal was sold in that year for $795, after service of sixty-seven years.

Colonel Hagner's latter years at the Arsenal during peacetime were rather quiet-he became quite deaf and carried a huge ear trumpet, but otherwise was still alert and active, although his duties were not so heavy. Only one sentinal was allowed for the

entire post, because of the small allotment of enlisted men, so that large "No Trespassing" signs sprinkled the grounds. On the wharf the Commanding Officer was more liberal, permitting "decent citizens and their wives and children to sit in the cool of the afternoon or evening," although the sign continued, "No games nor running permitted on these grounds. No unnecessary noise, nor bathing during daylight!" Always thoughtful of the enlisted men, he maintained a library from which a great many of the soldiers borrowed books. When the Adjutant General of the Army inquired whether there was a post school, or a necessity for one, Hagner answered both questions in the negative. The fifty children of the sixteen married enlisted men who lived on the post went to West Troy schools, and "all the enlisted men can sign their names, and with few exceptions, all young enough to be instructed can read and write pretty well." Ordnance soldiers were excluded from allowances of extra pay, so that it would have been an imposition to ask any Ordnance man to devote his time to teaching without remuneration; however, Hagner wrote that "when the strength of the detachment was sufficient to produce profit from baking bread, a post fund was thus obtained, and I had a night school for soldiers in operation under a hired teacher."

In the autumn of 1880, Colonel Hagner became ill, although he struggled out of bed many times against the doctor's orders and insisted on attending to Arsenal affairs. By December he was willing to admit that his health would not permit him to do the work he had carried on for seventeen years, and on December 3, 1880, he was relieved of his command by the arrival of Major Buffington.

Major Adelbert Rinaldo Buffington was well acquainted with Watervliet Arsenal, having been as assistant officer from 1869 to 1873 and temporary commander a number of times during Colonel Hagner's ab-

sences. As an assistant, he had been a hot-headed officer and became involved in a duel in 1869, following which he had been court martialed. During his period of punishment, one letter from Colonel Hagner to the Chief of Ordnance is recorded, asking whether Buffington might resume wearing his sword and be permitted to leave the post to attend church! However, he was an excellent officer, and rose to be a Brigadier General and Chief of Ordnance from 1899 to 1901.

Major Buffington's command of Watervliet Arsenal lasted only ten months, during which time the majority of work was routine, and the most startling event which marked the period was his own promotion. In July 1881, with twenty years of experience in the Ordnance Department behind him, he was promoted to the rank of Lieutenant Colonel. One matter of importance to Arsenal employees was the advance in prices in 1880 — wool, for instance, had risen twenty percent in one year's time — and the correlating rise in pay for the shop workers. Master Mechanics in January of 1881 received a raise from $4.25 to $5.00 per day. The enlisted men, however, did not share in the improved economic status of the hired workmen and when a discharged soldier asked if he could and should enlist again at the Arsenal for Ordnance duty, Major Buffington advised: "If you are not married and have no children, will be content to enlist as a 2nd Class Private with little or no prospect of ever being promoted beyond that grade, and can present a discharge with good character stating that you do not drink, you may present yourself for enlistment."

Monday, September 26, was a noisy day at the Arsenal. Honoring President James Abram Garfield, whose funeral was held on that day, thirteen guns were fired at dawn, twenty-one at noon and thirty-eight at sunset, with half-hour salutes during the whole day. This also could have been a farewell for Colonel Buffington,

who departed a few days later on official business and was permanently transferred never returning to Watervliet. Command of the Arsenal was assumed by Major Alfred Mordecai on November 2, 1881, the son of the commanding officer of Watervliet at the outbreak of the Civil War. He had been graduated from the United States Military Academy in 1861, and served with distinction in the Union forces. He had been stationed at Watervliet Arsenal as an assistant officer for a short time in 1864, and was the only officer to hold the command at two separate times — from 1881 to 1886 and from 1898 to 1899. The first five years of his command were not particularly eventful-the Arsenal shops continued routine work on infantry and cavalry equipment and began to make steel field gun-carriages. The years were strangely important, however, in the development of Watervliet Arsenal as the future "Cannon Mecca of America."

Chapter 6
Coversion to a Cannon Factory

On May 3, 1883, Congress approved an Act which was to have a profound effect on Watervliet Arsenal: "That the President of the United States is...authorized and requested to select from the Army and Navy six officers who shall constitute a board for the purpose of examining and reporting to Congress, which of the navy yards, or arsenals owned by the government has the best location and is best adapted for the establishment of a government foundry..., for the manufacture of heavy ordnance adapted to modern warfare, for the use of the Army and Navy of the United States...." The President was to report to Congress the findings of the board which, judging from the report of the Chief of Ordnance for that year, did not delay in beginning its work. They visited steel and iron works in America and Europe and on February 16, 1884, the Gun Foundry Board recommended "the establishment of Governemnt gun factories for both the Army and the Navy, and the making of a permanent and liberal appropriation by Congress for the specific purpose...to act

as a stimulus to private steel manufacturers to enlarge their plants, and make gun steel, the Government being a large purchaser." The need for a national gun factory was clear—by the 1880's the muzzle-loading cannon was becoming as outmoded as a muzzle-loading rifle. Up until that time, a cannon had been a rather simple affair—a stout cylinder into which a projectile and gunpowder were rammed and ignited by a fuse. Such cannon could be cast rapidly and easily by most foundries, but when breech-loading cannon were developed, their manufacture was a delicate and complicated piece of work, requiring much research and many experiments to improve the range and accuracy. It was obvious that further improvements would be made, as future wars brought more advanced methods of warfare. Only the national government could and would spend the money for research in peacetime and both research and production in wartime.

A "Board of Ordnance Officers on Location of the Army Gun Factory" was appointed on March 21, 1887, with instructions to visit Watervliet and Frankford Arsenals "for the purpose of determining...which arsenal possesses the greater advantages and the best existing facilities for the effective and speediest establishment of the plant in question." Lt. Colonel Alfred Mordecai was one of the four officers making up the board—he had left Watervliet Arsenal in May, 1886, when he was assigned to the board which was studying the needs of a cannon factory-which had a number of yardsticks by which to choose the "Army Gun Factory." The Ordnance Department directed:

"A careful examination of the machinery, tools, motors, and appliances at the two arsenals which may be used in the manufacture of cannon, whether field, siege or seacoast. It is the intention of the Department to concentrate its available gun plant at one place, believing that such a policy will inevitably result in economy and efficiency of manufacture and probably in

the steady growth of an establishment that may ultimately prove adequate for the manufacture of experimental guns and service guns to a limited extent. The guns that the Department has now under manufacture or contemplates manufacturing during the rpesent and the next fiscal year are as follows: Twenty-five 3.2-inch breech-loading field guns, steel; one experimental 5-inch B.L.seige rifle; one experimental 7-inch B.L. Howitzer; one experimental 8-inch B.L. rifle.

"The board will determine which of the two sites named is, on the whole, best adapted for the purpose from the character and extent of the shops and appliances that would be required; from buildings already erected at either point; from the proximity of the place to the establishments that will probably furnish the material to be worked; its security against hostile operations; its facilities as regards transportation of materiel and guns, both by water and rail; its proximity to the centers of skilled labor, manufacturers' supplies and fuel. Facilities for a proof-butt, convenient to the works for firings and incidental to the manufacture—as the setting out of lining tubes of guns—are a desideratum and, if practicable at either point, should receive due consideration."

When the board made its report the following month, most of the advantages lay with the Watervliet Arsenal. The cost of removing the plant on hand at Watertown Arsenal in Massachusetts to Watervliet, installing it, making some necessary alterations and repairs of buildings, and furnishing power was estimated to total $9,500, while additonal machines, and altering and enlarging those machines on hand to increase the plant to the required capacity would involve only another $11,705. These sums were lower than for the same work at the Frankford Arsenal. The Board also believed that, because "the cost of living is less at the former place and because, the distance being less, many who have homes

FIRST GUNSHOP — Brick warehouse was converted into first shop for manufacture of cannon.

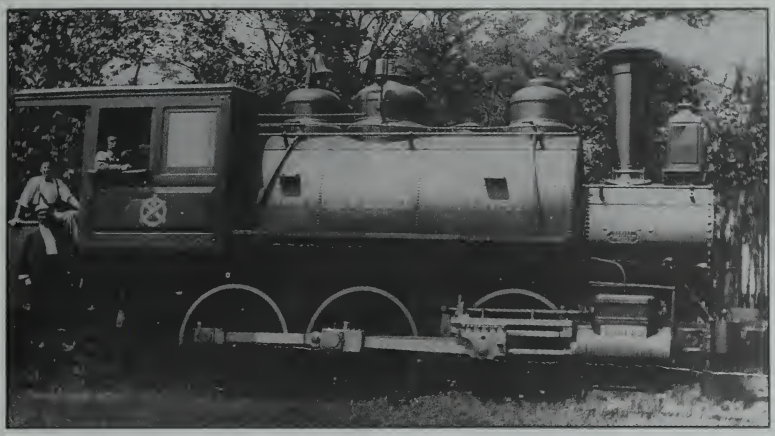
could retain them and visit their families occasionally until they are ready to move them," more of the skilled workmen from Watertown would be willing to move to Watervliet than to Frankford. There was plenty of shop room for work on field and seige guns. It was discovered that one of the large brick warehouses west of the Erie Canal was suitable for alteration into a gun shop, with power to be furnished by the canal and a portable 12-horsepower engine from Watertown.

Many other factors, of course, entered into the choice. The Watervliet Arsenal had "the more rigorous climate and lowest average temperature, causing outdoor work to be more interfered with in winter, but causing workmen to accomplish more work per day in summer." The Watervliet Arsenal was "absolutely safe from hostile fleets and vessels," while Frankford's location near Philadelphia made it more vulnerable. Watervliet Arsenal "could collect from the state of New York and from

the highly-skilled mechanics of New England, the labor needed that could not be found in Troy or the immediate vicinity. Rents and the cost of living are less at West Troy and the same quality of labor is cheaper. There would also be less interference from strikes and other labor troubles; on account of its position it would be less subject to attack by hostile mobs and more readily defended from them."

Transportation was an important factor, and the rail and water connections at Watervliet were found to be superior. Coal and gun metal could be brought in cheaply and easily and, conversely, no difficulties would be met in taking the guns out of the plant. Geologically, requirements were also met; the good rock foundation of the grounds would furnish an excellent and economical base, if further extensive building were necessary. The grounds north of the canal presented ample space for any future expansion. In conclu-

GUNMAKERS — The first group of arsenal gunmakers gather for a portrait outside gunshop.



YARD ENGINE — A railroad yard service was added to move the heavy guns to shipping areas.

sion, the Board advised: "The Board is of the opinion that Watervliet Arsenal is better adapted than Frankford for the concentration and installation of the present gun plant of the Department, and for the establishment of a fully-equipped gun factory."

No time was lost following the selection of the site for the cannon factory. Work was started in the fall of 1887, before funds had been appropriated, and the following year Congress voted $700,000 for the change. The commanding officer of the Arsenal from June 1886, until November 1889, was Colonel James Whittemore, who supervised the revolutionary activities. Production shifted from haversacks, canteen-covers, harness, saddles, and gun carriages, to small cannon. The construction of the large seacoast cannon shop was planned. Colonel Whittemore's characteristics, according to his intimates, were as follows: he was a "small, rather fussy man, very amiable, and was something of an inventor, although his inventions frequently did not prove successful." These characteristics proved to be ample for his capacity of Commanding Officer during this most important period. He had been stationed at the

Arsenal as an assistant officer to Colonel Hagner from 1866 to 1868, and received his promotion to Colonel the year after taking command.

Work was actually started October 18, 1887. Machines and tools brough from other arsenals were supplemented by some purchases, and the two-story, brick-timber storehouse was remodeled to suit it for the manufacture of smaller artillery pieces as well as for some types of seacoast cannon. The storehouse was 392 feet long and 50 feet wide, and within a few months was equipped with machinery, cranes, and shrink pit facilities.

Colonel Whittemore was named president of a board of officers which was appointed "to convene at Watervliet Arsenal on October 4, 1888, to prepare the necessary plans, specifications, and estimates covering the expenditures of appropriations made by acts of Congress, as follows:

"First: For the erection, purchase, and manufacture of the necessary buildings and other structures, machinery, tools and fixtures for an army gun factory for finishing and assembling heavy ordnance, to be erected at the Watervliet Arsenal, West Troy, New York—$700,000. Provided that not exceeding $20,000 of this sum may be used for the erection and completion of two sets of officers' quarters and that all tools, machines, and materials for said guns shall be manufactured in the United States.

QUARTERS — New quarters for the assistant commander.

"Second: For providing increased facilites for the manufacture of projectiles—$10,000.

"Third: For a hand-power loading crane, 50 tons capacity, for use in shops—$3,000.

"Fourth: For two traveling cranes, 30 tons capacity, for use in the shops—$24,000.

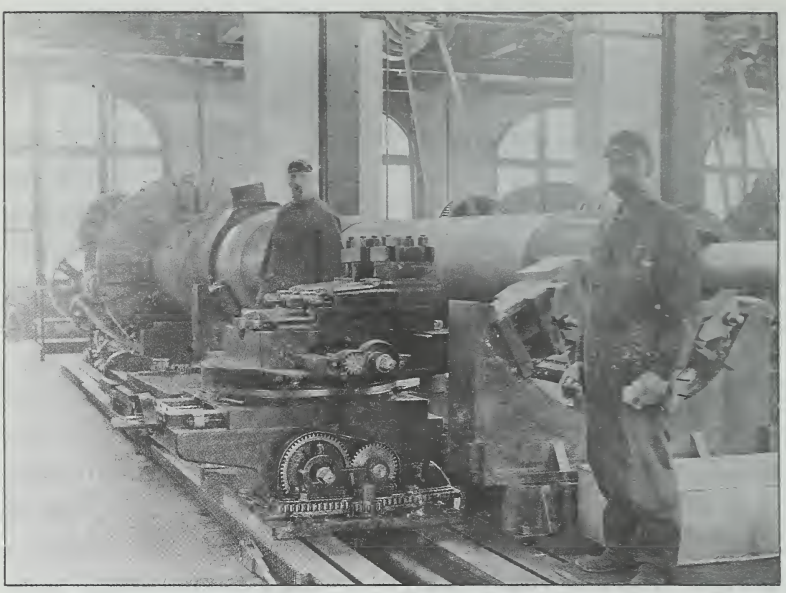
"Fifth: For necessary railway facilities in Arsenal grounds, connecting shops with Delaware and Hudson Canal Company Railroad, Erie Canal and with the Hudson River — $8,450

"Sixth: For replacing the present old and unsuitable wooden bridge over the Erie Canal with an iron bridge, capacity 130 tons— $15,000."

The Gun Factory Board spent a year drawing up plans and specifications which were submitted to the Ordnance Department and were accepted in 1889. The detailed and precise report filled seventy-one pages of fine type in the book of Ordnance Reports for that year, and the data covered everything from the exact size of the links in a hoisting chain to the copper-lined bathtubs to be installed in the two new quarters. The board also had the responsibility of advertising and accepting bids for the construction of all the projected buildings and the manufacture of machines and tools needed.

Standard machines were not satissfactory for making guns, and the plans for the new machines had to be

NEW BRIDGE — A new iron bridge replaced the former wooden structure over the Erie Canal.



SHOP SCENE — The new Seacoast Cannon Shop north wing was started in 1889.

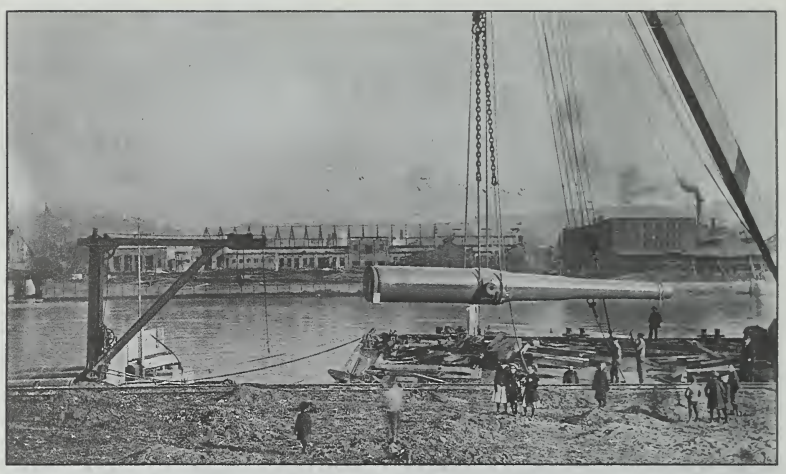
worked out carefully. Mr. Anthony Victorin, engineer in charge of designing and constructing the gun factory, gave valuable assistance and his advice was in constant demand. So that he might live inside the Arsenal walls and be available for duty at all times, the magazine-keeper's quarters were remodeled and refurnished for him in 1890. Mr. Carl Alfred Christiansen, as foreman of the Seacoast Cannon Shop, also played an important part in the establishment of the gun factory.

The north wing of the Seacoast Cannon Shop was started in 1889, and was completed the following year. At the same time the central section of the shop was constructed and contained a boiler house, engine room with a shrinkage pit fifty feet deep, offices, inspectors' rooms and tool rooms—all to be used in common with the south wing, which was finished three years later. As originally built, the central section was 166 feet long and the north wing 400 feet, but Congress appropriated

$248,743 to build the south wing and $268,000 for machinery for that section in February 1891, and after this addition and the extension to the building during World War I, the building was about 1,300 feet in length. It was not constructed without difficulty — some walls had to be torn down and rebuilt and some were strengthened with stay rods—the contractor claimed that the plans were defective, while Colonel Whittemore maintained that the workmanship was defective. However, it was completed, and a good job was done. For many years the Seacoast Cannon Shop was the largest and most important shop in the Arsenal.

Building was in progress in all parts of the Arsenal. Railroad lines were run in from the west, extended from the new gun shops down to the Hudson River, and a stout bridge over the Erie Canal was constructed for the new lines. The officers' quarters, later called Quarters Two and Three, were completed int he fall of 1889, at which time the first occupants moved into them. The old Iron Storehouse was emptied of some 5,000,000 pounds of nitre and sulphur and the building was outfitted with fifteen furnaces, as well as the other machines and appliances necessary for a projectile foundry. Casting of projectiles was carried on for three or four years, but the results were unsatisfactory, and in 1894 the foundry was closed and the machinery was transferred to Watertown Arsenal. The 287,448 pounds of supplies stored in the old stone arsenal were shipped to the New York Arsenal, and the building was demolished. Efforts were made to buy land close by the Arsenal grounds to build a proof-butt for testing cannon, but the astonishing rise in the price of the land killed the project and the big guns were shipped to Sandy Hook Proving Ground in New Jersey for testing.

Colonel Whittemore left the Watervliet Arsenal on November 11, 1889, to assume command of the Rock Island Arsenal, and his successor, Lieutenant Colonel



LOADING GUNS — Large seacoast guns are loaded on barges for shipment via Hudson River.

Francis H. Parker, arrived at Watervliet ten days later. Colonel Parker had been a member of the board which had selected Watervliet as the site of the gun factory, and was especially selected to be commanding officer because of his previous experience in the manfuacture of field guns at Watertown Arsenal. He was a very tall man with "very long legs and was known throughout the service as 'Shang' Parker. 'Shang' was a contraction for Shanghai, referring to a variety of rooster with long legs," according to his intimates at the Arsenal.

A commanding officer who had actual experience in making field guns was vitally important to Watervliet Arsenal in its early stages of manufacturing—many difficulties had been met in making the first guns. The cost of the first 10-inch gun, which the Ordnance Department had estimated would be $14,000 actually was $21,321.87. Colonel Parker believed, however, that "certainty of success and excellence of workmanship in this new work is of more importance than strict economy of expenditure." The costs of all types of guns were figured carefully and were presented to the Ordnance Department,

12-INCH GUN — Marking the number on a 12-inch gun in the Seacoast Gun Shop in 1896.

in order to give a clear pciture of the work and expense involved, and included itemized statmenets. In his report on work on a 3.2-inch gun "modified for the Driggs-Schroeder breech mechanism," Colonel Parker stated that it had cost $411.09 to prepare the gun for reception of the breech mechanism, $552.08 for the breech mechanism, $320 for tool dressing and special tools, and $50 for drawings. With more experience and larger quantities of guns to be manufactured, Colonel Parker hoped to reduce costs considerably. In 1891, the Ordnance Department reported that an 8-inch gun had cost $15,646, a 10-inch gun, $30,592, and a 12-inch gun,

$47,227.

The Ordnance Department was especially interested in the first 12-inch gun made at the Arsenal. The preliminary forgings of tube, jacket, trunnion hoop and A-1 hoop had been made at LeCreusot, France, which led to trouble, as it was discovered three months after work had started on the gun that the tube and jacket had not been properly annealed and it had to be shipped to Bethlehem, Pennsylvania, for reannealing. Work was started on the gun in July 1889, and it was completed in June 1891.

While work progressed on the guns, other departments were also busy. The projectile foundry in the year ending June 30, 1891, had cast 9,816 projectiles of different calibers and approximately five tons of additional machine castings. Caissons and battery wagons were produced in the carpenter shop. That same year a new water system was installed—when Colonel Parker had discovered that the water was pumped from the Hudson River or from the canal and, in either case, "was foul with sewage and filth," he declared that the most serious deficiency of the post was the lack of an adequate water supply. There was not enough pressure for fire fighting nor for use on the second floor in the officers' quarters. "Drinking water was obtained from a well in the northeast corner of the grounds and was hauled daily in barrels to the quarters, shops, and offices, consuming the labor of two men and a horse and truck. This was probably the most entirely inadequate and inconvenient method of furnishing water at any large post in the country." Arsenal water pipes were connected with the West Troy water system, and a water tower was built in 1896 to increase the pressure of the post's water supply.

The detachment of fity-five enlisted men stationed at the Arsenal played a role of diminishing importance while the gun factory was being established. Most of the soldiers were put to work as unskilled labor on the con-

struction of various buildings. As a consequence, fewer men wished to enlist in the Ordnance Department and in the six years from 1885 to 1890 only eighty-one men enlisted at Watervliet — of that phenomenally low number, thirteen deserted and twenty were given a "Bad Character" on their discharge papers. The workmen were also dissatisfied—those men in the Broadway Shops had lowere wage rates for the same skill that brought the higher wages to the men in the gun factory, and the men working on guns had a ten-hour day, which increased their pay still more. The employees in the gun shops were now divided into five groups, the first of which paid $4.00 a day and was composed of highly skilled workers on the big lathes, or on 8-inch and 10-inch tubes and jackets, who were capable of taking a foreman's place during his absence. The second group, paid $3.48 per day, were able to do the same work but did not have the supervisory capacity. In the third grade were included the workers who were especially fitted to do certain kinds of work not so highly skilled, such as boring large hoops, turning tubes, and so forth. Men in the fourth class entered the shop without any special knowledge of gun making, and were paid $2.24 to $2.72 while they learned. The unskilled laborers making up the fifth group received $1.50 per day.

Higher wages were needed, in some cases, to offset the accidents which occurred—most men were unfamiliar with the new machines and did not realize the hazards peculiar to the industry. One man was killed on a lathe shortly after the gun shop began operations, and minor accidents were numerous. The men worked from seven o'clock in the morning until six o'clock in the evening during summer, or five o'clock during the winter, until 1892, when Congress passed a bill ordering an eight-hour workday which caused some confusion for awhile, as the same amount of work had to be crowded into a fewer number of hours. Machinists in

the Seacoast Cannon Shop tried, at that time, to form a union and went on strike to gain recognition—they gained nothing, but a few days' work on the big guns was lost.

In the summer of 1892, Colonel Parker was given a six-months' sick leave and never returned to the Arsenal—he died five years later. His successor, Major Isaac Arnold, Jr., assumed command of the Arsenal in December and held it until February 14, 1898. Major Arnold was promoted to the rank of Lieutenant Colonel a year before he left the Arsenal. Those who knew him when he was the Commanding Officer reported that he was "a man of rather rough manners and some eccentricity. He was accustomed to walk around the post in carpet slippers. His greatest enthusiasm was reserved for fishing and hunting."

One of the first improvements made under the command of Major Arnold was the establishment of an electric power plant for the post. The gas lights were cut off in June 1893, as the pipes had corroded so badly that serious leaks occurred in hundreds of places. The Arsenal had to revert to kerosene lamps for light for a year and one-half. The electric plant was completed by June 1894, but a court injunction prevented its use. An electric company charged that the company which had installed the plant at the Arsenal had infringed on patents owned by the first company and the dispute was not settled—nor did the Arsenal have electric lights—until the following winter. The "electric lamps" were carefully allotted to the various buildings; the hospital was allotted "twenty-two 16-candlepower incandescent lamps," and the offices were lighted by fifteen of such "lamps". Fifty 50-candlepower lamps were used to light the walks and drives, while the Seacoast Cannon Shop had "three single carbon arc lamps, thirty-five 50-candlepower lamps, and two hundred and fifty 16-candlepower incandescent lamps."

At frequent intervals for many years, the village trus-

NEW OFFICES — The new office building is shown at the end of the long entrance road.

tees of West Troy passed resolutions deploring the state of that part of Broadway which passed through the Arsenal grounds along the river, and the government was finally shamed into paving that portion of the street with granite blocks in 1892 and 1893. Some paving of the same type was laid on the main Arsenal streets at that time, also, although evidences of the old Arsenal work were still to be found in 1894. That same year Major Arnold complained that 90,000 pounds of gun powder were still stored in the East Magazine, 400 feet from the big gun

shop, and dwelled at some length on the results to the $2,000,000 worth of new shops if lightning should strike the magazine. His vivid letter resulted in action on the part of the Ordnance Department, and most of the gun powder was removed.

Money for a new office building was furnished in 1894, although funds for the construction of guns were sharply limited. The new offices were constructed close to the north end of the small gun shop and, in later years, two sections were added to the original building and during World War II, two wings enlarged the office space. The small office building east of the canal continued to be used until 1901.

The civilian employees at the Arsenal were brought under Civil Service in 1896 and for a time everything connected with these employees, whether an increase or decrease in pay or an application for employment, was reported in a separate letter to the Chief of Ordnance. This avalanche of paperwork necessitated an increase in the clerical staff to include one chief clerk at $1,600 a year, four clerks at $1,200 a year and one "typewriter" at $830 a year. Typewriters had come into use at the Arsenal in 1887, when the first operator was hired, with the understanding that she furnish her own machine. When her typewriter ceased to work five years later, the Arsenal was forced to spend $107 to buy a new one. However, until 1990 all official letters were copied by hand into the Arsenal Record Books, and many letters sent out were handwritten.

Gun production was cut still lower in 1896 to keep within the funds appropriated. A large number of employees were discharged, and the shops were running at one-half their full capacity. One year later the small field-gun shop was closed and the Seacoast Cannon Shop was working slowly, hampered by delays in receiving forgings and lack of funds. Smokeless powder was introduced in 1897, which necessitated the alteration in the design of the guns.

Nevertheless, the buildings and equipment were impressive, and the Watervliet Arsenal was somewhat of a showplace for the Federal Government. Delegates from the Universal Postal Congress, representing some sixty nations, visited the Arsenal and were shown some of the operations of the big gun shop. President William McKinley also inspected the Arsenal in 1897, the first time that a President of the United States had visited the post while he was in office.

Watervliet Arsenal, as a manufacturing plant, was now ready to play an integral part in the arming of the United States forces for the action which was imminent. On February 15, 1898, the battleship "Maine" was blown up in Cuban waters and eight days later Colonel Alfred Mordecai returned to the Watervliet Arsenal to speed up work on big guns. The nation was once more preparing for war.

Chapter 7
Spanish-American War to World War One

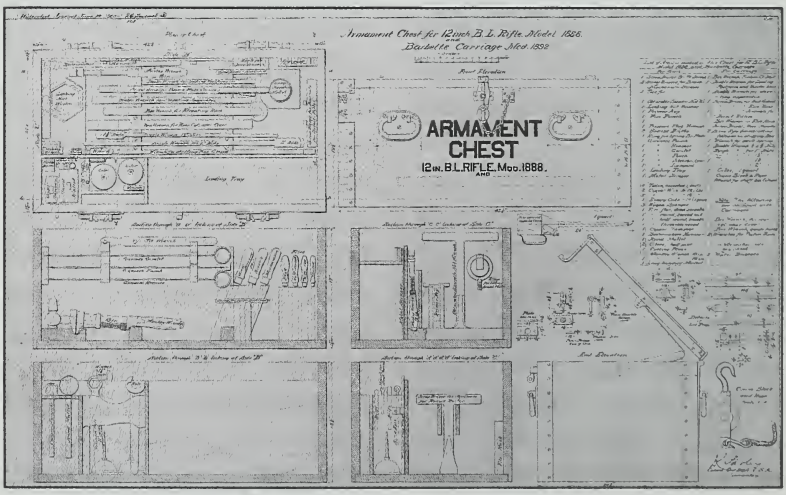
When Colonel Mordecai arrived at the post there were 482 workers — the maximum number employed during the war was 634 in June 1898. The Arsenal buildings and machines were new, and in good condition. However, he reported: "The principal and most serious difficulty experienced was the procurement of machinists sufficiently skilled for gun construction. It became necessary to employ men of all grades and of unknown ability and to try all who, from their own statement, might appear at all favorable. Although some 200 workmen were employed in about two months, not over six were found capable of being graded as first-class machinists.

"Some of these men remained only a few days, and others only a few hours, when they had to be discharged for incompetency. A number, wanderers from their homes, were willing to remain but a short time, and still others resigned on account of the impossibility of being promised employment permanently or even for a definite length of time. At no time was it found possible to obtain all the machinists desired. Thus it was shown the impossibility of procuring in

an emergency from this vicinity, where there is little or no supply to draw on, workmen of the quality required for gun construction. The advantage of operating the gun plant continuously and uniformly is therefore apparent and more marked than for other manufacturers of the Ordnance Department." And thus one of the chief problems came to the foreground which had evolved out of the change in the Arsenal's status. Highly skilled men were now necessary, and finding the men with the necessary qualifications would henceforth be difficult.

By April the Ordnance Office was making inquiries as to the changes that had been made to increase production in the shops. Colonel Mordecai informed them that a night shift had been put on in the Broadway Shops, additional men had been added to the day shift in all the shops, and to the night shift in the gun shops. The capacity of the machine and blacksmith's shops had been doubled, that of the carpenters' shop and the small gun shop increased seventy-five percent, while the big gun shop showed no material increase. The Arsenal received instructions "to fix and prepare for issue all shells for field artillery ammunition," and later orders were received "to make cartridges for this ammunition, and shell for the siege service should be prepared for issue." Colonel Mordecai replied: "To accomplish this work a shed was erected at the door of the east magazine, under which cartridge bags were filled, and a shed situated by the railroad track north of the barracks was emptied of lumber and fitted with floor and windows, to be used for filling and packing shell. A platform with ramp was erected so that shipments could be received into and made direct from the building. These facilities permitted of 2,000 field shells being filled, packed, and shipped in a day. In filling cartridge bags with Du Pont smokeless powder, much labor was required to pack the powder in the bag, continued pounding with a stick being necessary."

Congress declared that a state of war with Spain had existed "since April 21, 1898." Smaller guns were needed quickly for issue, so that work on the first 16-inch gun was halted, although the forgings had been received in February. In the year ending June 30, 1898, a total of 190 field, siege and seacoast cannon had been finished at the Arsenal, and in the following year 134 cannon were made. Complete with tools and supplies, 309 armament chests for big guns were made in the Broadway Shops, and a total of 1,589 seacoast projectiles were banded, painted, and boxed in the same period. During that summer, there were also manufactured 9,195 cartridge bags for 3.2-inch rifles; cartridges for the same size gun to a total of 14,980; shells prepared and packed for issue for guns from 3.2-inch to 7-inch size came to 24,112. Private manufacturers sent in 58,870 shells for guns ranging from the 3.2-inch rifle to the 7-inch howitzer, and 77,600 pounds of gunpowder were received from private powder companies. In speaking of these outside contractors, Colonel

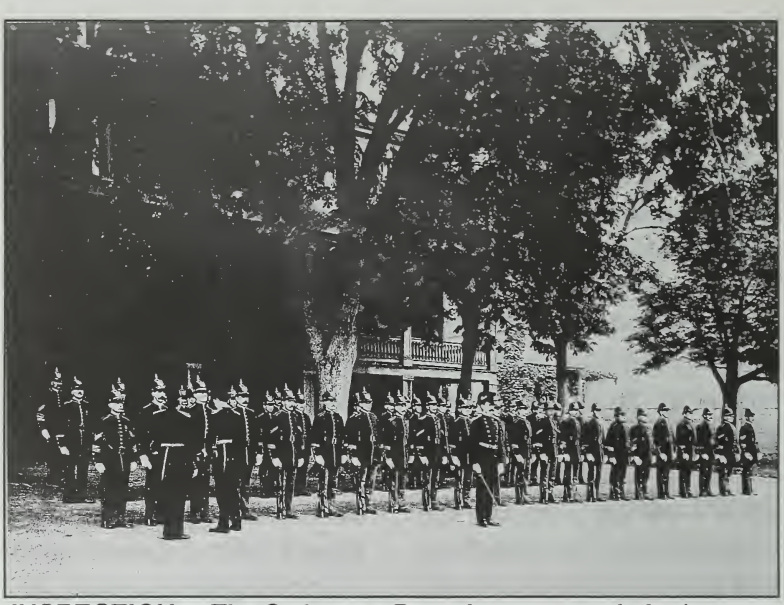


ARMAMENT CHEST — Among the products manufactured was this armament chest for the 12 inch B. L. Rifle, Model 1888.

Mordecai regretted that "much difficulty was experienced with all the manufacturers, arising from their ignorance of what the Department actually required. None of them had had any practice in such work, did not appreciate the requirements of the specifications, or attribute to them any meaning beyond what they had been accustomed to observe in their usual business; that the dimensions must be within certain limits or the interior of the shell be clean and smooth conveyed little idea to them, and it was only after many delays and rejection of much imperfect work that a proper understanding was established and projectiles suitable for acceptance were turned out." It became apparent right here that the Watervliet Arsenal would have to be the source of information for the private contractors who became necessary during wartime — from the Arsenal guiding hands must stretch forth to the various companies, help coursing from their arteries so that the much needed material could flow back through the veins to the heart — the Arsenal itself. Projectiles made at Rome, Syracuse, and Troy, New York, were inspected by officers from the Arsenal under the supervision of Colonel Mordecai. Most of the guns and ammunition made at the Arsenal were shipped by fast freight to Tampa, Florida.

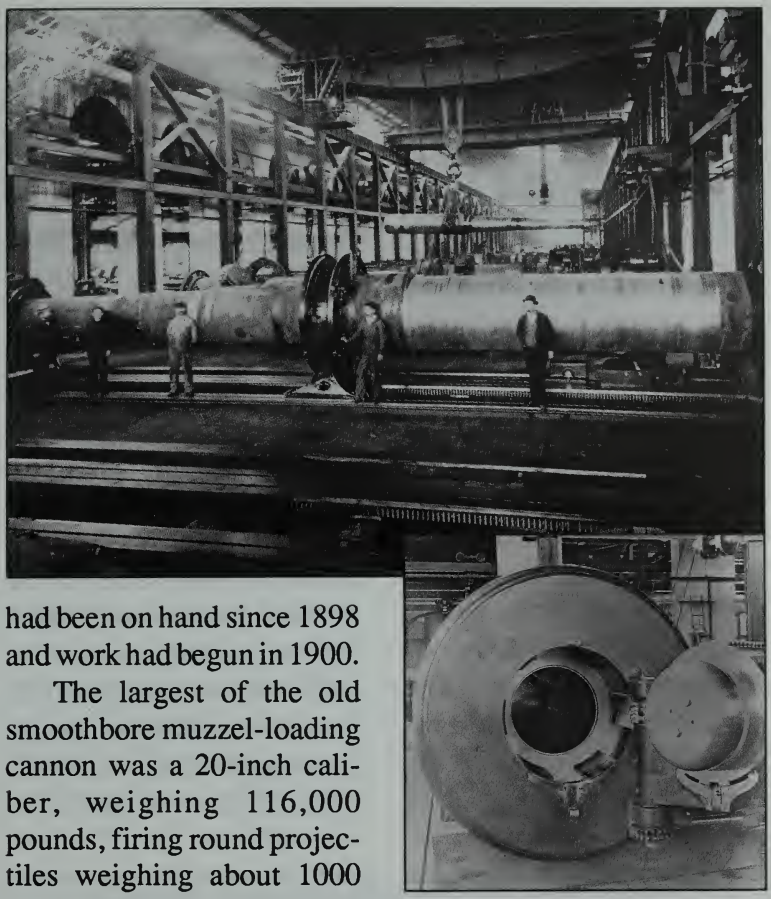
The Spanish forces in Cuba surrendered in mid-July, Manila fell on August 13, and fighting ceased, although a treaty was not made until December 10, 1898. During the four months of war, the Arsenal did not have time to prove its capacity for production, although it was obvious what could have been done if it had been necessary! It had not been a mistake to choose Watervliet Arsenal as the nation's cannon factory. With the closing of war, a period of twenty calm years began, devoted to manufacture to a small extent and constant experimentation and improvements.

The first task undertaken by the Arsenal was the production of the first 16-inch



INSPECTION — The Ordnance Detachment stands for inspection outside the Barracks in 1901.

breech-loading rifle. As early as 1891, the Chief of Ordnance had decided to procure the necessary machines and tools to make such a a gun, and it became the first of a series of similar gigantic weapons which were used for the seacoast defense of the United States. A few rifled guns of equal or slightly larger caliber had been made previously in Europe, but none of them compared in point of energy and range with the 16-inch gun made at the Arsenal. The first model produced weighed 385,400 pounds, was 49 feet long, and fired a projectile weighing 2,370 pounds which had a range of approximately twenty-one miles. The cost was $91,816. This gun was much like the 12-inch guns which the Arsenal had been turning out, but the greater size required larger lathes, cranes, and rifling machines. The shrink pits which had been large enough for all the other guns proved to be too small for this monster. For these reasons, the first gun was not completed until June 1902, although the forgings



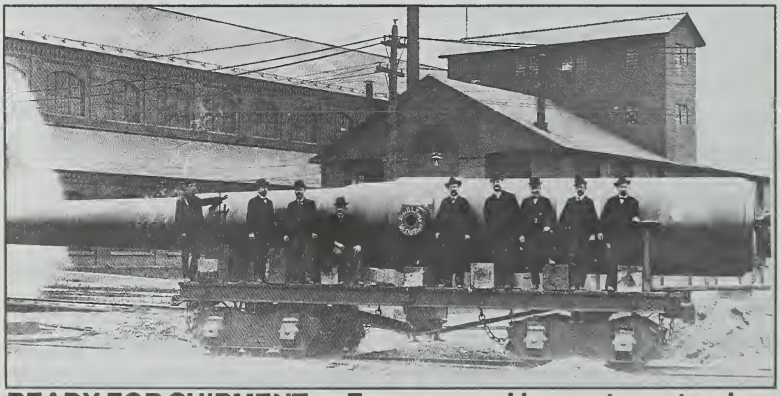
had been on hand since 1898 and work had begun in 1900.

The largest of the old smoothbore muzzel-loading cannon was a 20-inch caliber, weighing 116,000 pounds, firing round projectiles weighing about 1000 pounds. The range and aiming accuracy of such guns were very limited. They were cast of a single piece of metal, but for greater strength, the Arsenal made "built-up" breech-loading guns. A built-up gun is composed of a tube covered with a number of jackets or hoops, the greatest number encircling the breech end of the gun where the pressure of explosive gasses is most intense. The inner diameter of each jacket or hoop is slightly smaller than the outer diameter of the preceding hoop. The hoop is

FIRST 16-INCH — No. 1 16-inch, shown with breech open, above, and in lathe, top. Carl A. Christiansen is at left in top photo.

heated to make it expand, and is then slipped over the cool gun. As the hoop cools, it shrinks to a tight fit and then the gun is ready to receive the next hoop.

The first hoop that was applied to the first 16-inch gun weighed 74,000 pounds. The crane operators practiced for weeks the correct procedure, raising the hoop from the cold furnace and lowering it onto a dummy tube made of wood. When they felt sufficiently accomplished, the first hoop was heated in the cylindrical pit furnace for two days, checked and measured periodically to see that it was expanding correctly, and finally was lowered onto the tube. It rubbed against the tube when within six inches of the correct position. The crane was immediately reversed, the hoop removed and returned to the furnace to cool for three days, after which it was carefully examined to determine whether it had straightened while cooling, and the slight burrs which had been attained by rubbing against the tube were removed. The tube was examined and one week after the first attempt, the furnace burners were again lighted to heat the hoop. A day later it was successfully shrunk in place, the operation consuming one whole day. Water was applied to



READY FOR SHIPMENT — Foremen and inspectors stand on rail car with first 16-inch gun ready for shipment in 1902.

the muzzle of the gun in less than a half-minute after the hoop was in place, and the cooling water was poured over the gun for nine hours. So much was used during the cooling that the lower part of the shrinkage pit was filled with water to a depth of twenty-six feet, despite the fact that the steam pump was running constantly.

With the first hoop finally in place, the workmen had to continue with the slow process of applying the remaining ten hoops to the huge gun and, when the assembly was completed, the final boring and rifling had to be done. Rifling, of the spiral grooves cut in the bore of the gun from breech to muzzle, causes the projectile to spin, thus keeping it point-foremost in flight and producing the three gravely-important characteristics of range, accuracy, and penetration. Oblong projectiles were found to be superior to spherical projectiles because of their greater penetration, heavier bursting charges, superior accuracy of aim, and greater range. The final step

POSING — Foremen's children at muzzle of first 16-inch gun.

in making the gun was to put in the breech mechanism, which seals the breech while the electric spark touches off the explosive. The breechblock had a diameter of twenty-six inches, and a total length of twenty-seven inches, with a compound gear in which the teeth were arranged so as to perform both the rotation and translation of the breechblock. The mechanism was designed to be opened or closed with one continuous motion of the rotating crank; twenty-two and one-half revolutions in one direction opened the gun and the same number in the opposite direction closed it. The finished dimensions of the bore were within one-

half of one-thousandth of an inch of the prescribed dimensions, although the allowed variation was three thousandths of an inch. When the loading wharf had been strengthened to bear the enormous weight, the gun was shipped to the Sandy Hook Proving Ground to be fitted with a disappearing carriage and tested.

This description, although but a bare outline, gives an idea of the problems involved in the making of one gun and of the excellence of the final results obtained through coordination and hard work. Experiments were carried on continuously to improve the guns of all types and caliber. The wire-wound cannon was the object of much experimental work. This weapon had a tube covered with wire, wound under controlled tension but even when wrapped with the greatest care, the guns still had a longitudinal weakness and, after a certain amount of firing, the barrel would develop a dip or bend. The Ordnance Department hoped that a lighter weight gun would be produced which would still retain the strength of the built-up guns. Another problem was the construction of better shrink pits and pit-furnaces. The first furnaces were coal-burning, but the one constructed for the making of the 16-inch gun burned a mixture of kerosene and high-pressure steam. Later, kerosene with compressed air was used, and in 1908, fuel oil was introduced, but complete satisfaction was not obtained until electric furnaces were installed in 1920.

For four years after the Spanish-American War, the Arsenal was commanded by Colonel Joseph P. Farley, who had graduated from West Point in 1861. He was the author of several books of personal recollections and a great social favorite. Although shop work along experimental lines kept him busy, the production schedule was not pressing so that he had time to pay particular attention to the improvement of the buildings and grounds. The vegetable gardens for the officers and men of the post had been located in the rear

FOUNTAIN ADDED — A decorative fountain was one of many embellishments to Quarters One made by COL Farley.

of the commanding officer's quarters until Colonel Farley had them moved to a less conspicuous spot south of the Iron Storehouse and a flower garden substituted in their original location. The ornamental fountains made of small guns, mortars, and cannon balls were designed by Colonel Farley, as well as the decorative gate on the main Arsenal drive made of ancient cannon. A distinctive greenhouse immediately north of the commanding officer's quarters was also built.

After forty-two years of service in the Army, Colonel Farley was promoted to the rank of Brigadier General in February 1903, and was retired on his own application

the following day. He was succeeded by Lieutenant Colonel Charles Shaler, who was in command for only five months, and was followed in July by Lieutenant Colonel Daniel M. Taylor. During his command, work for the Navy Department was started, and there was increased electrification of equipment in the Arsenal workshops. By 1904, the number of employees had dropped to 490, but the shops were busy with twenty-four guns each of 7 and 8-inch caliber and the first 6-inch rapid-fire wire-wound gun made in the nation was completed.

Colonel Taylor was obliged to relinquish command of the Arsenal on February 9, 1905, because of illness. Temporary command was held by Major L. L. Bruff until May 1 when Lieutenant Colonel Ira MacNutt arrived. Work at the Arsenal was cut sharply, as funds for the Ordnance Department had been similarly cut in 1904, and the employees on the payroll dropped to 377. Colonel MacNutt regretted that "appropriations are not sufficient to employ this fine plant, a considerable portion of which must, therefore, stand idle during the year." There was one important improvement in the Arsenal early in Colonel MacNutt's command. In 1905, a local telephone exchange with twenty-nine instruments was introduced, which greatly facilitated the transaction of the business of the post and was a great step in furthering the efficiency of the fire alarm system of the Arsenal.

NAVY GUN — Open breech of 8-inch Navy gun.

In 1906, the first job of relining a big gun was completed in the shops and represented a major accomplishment. Heavy charges of gun powder rapidly eroded the

lining of the big seacoast guns, destroying the accuracy of aim. By heating the gun while cooling the innermost tube, the lining could be shrunk away from the layers of jackets and removed. Thus a new lining could be inserted and the gun made serviceable again at low cost. On the first job, only the barrel received a new lining, and not the powder chamber, but the next year the shrink pit was deepened twenty-three feet to permit the insertion of full-length liners in guns of the larger calibers. In 1910 the pit was deepened again to a depth of ninety-one feet which, the commanding officer believed, would be sufficient to accommodate all guns to be relined for many years.

Lieutenant Colonel William W. Gibson succeeded Colonel MacNutt in January 1908, and was in command of the Arsenal for ten years. The years from 1908 to 1917 passed quietly by, although noticeable trends could be traced in employment, reflecting the changing times. There were 377 employees at the Arsenal when Colonel Gibson assumed command, and this number dropped year by year until a low of 214 was reached in 1910. Peace seemed permanent. From that year until World War I, however, the figure gradually rose. In 1912 Colonel Gibson became a full Colonel and by 1916 there were 422 employees on the rolls. The rumblings of expansion began to be heard, although Congress was loathe to appropriate money for the manufacture of guns and the people of the United States refused to believe that they would be involved in war.

The few guns made at the Arsenal in the period preceding World War I were modeled after guns previously developed, with one exception-the "balloon gun." In 1909, the Chief of Ordnance, General William Crozier, proclaimed: "The attack of dirigible balloons and aeroplanes, of which the use in future wars, at least for purposes of observation, is highly probable, is being given consideration. Experiments for the accumulation

of data are in progress and a gun and carriage are being designed. The subject is yet in its infancy, but the difficulty of successful attack against such machines is readily apparent. They move rapidly, change direction quickly, alter their elevations at will and are removed from any objects that assist aiming.

"The great angle of elevation that may be expected introduces complications in sighting. For short ranges, it is probable that the fire of the small-arms rifle or of machine guns against the personnel will prove most effective, but for the longer ranges field artillery must be employed. The best type of projectile to use is yet undetermined, as sufficient accuracy for effective time burst would be difficult to attain, and the resistance offered if a balloon is struck is not sufficient to operate a percussion fuze that would be safe in firing and transportation. While the difficulties are considerable, they are not believed to be insurmountable and when sufficient experience shall have been gained, satisfactory material and an efficient system of fire control will doubtless be developed." The Watervliet Arsenal set to work on the difficult problem and produced the first "balloon gun" in 1910-a 6-pounder, 2.24-inch caliber prelude to bigger and better antiaircraft cannon.

Attention was turned to Arsenal organization in 1911, and two vital additions were made to the Organization Chart — the Engineering Division and the Planning Room. The Engineering Division greatly simplified the issue of all orders to manufacture by giving the exact number of parts to be manufactured, repaired, or altered, the exact number to be turned in to the storehouse, and the condition in which they were to be transferred. This insured uniformity in all cases of shop records, property returns, and reports of operations. Materials of the proper kinds and in sufficient amounts were obtained to complete the work on order. The drawings, plans, and specifications issued to the

shops were kept up-to-date, and those superseded by any changes were promptly withdrawn to prevent confusion or error. When an order was issued to the shops it was ready to be executed — the necessary funds had been provided, orders for materials had been issued, and complete instructions, prints and authority for drawing the necessary materials accompanied the order. The Planning Room also had a large over-all job with many details to consider. It was responsible for arranging work in the shops which involved endless checking of machines, machine jobs, and men to do the job. The real job started where that of the Engineering Division left off, although there was no clear-cut line of demarcation, of course. The Planning Room worked with machines, men, and material. Efforts were made, beginning in 1911, to introduce the "Taylor System" into the shops — a method of paying workmen extra premiums for work accomplished above a set goal. Labor unions all over the nation objected loudly to such a system in government-owned arsenals, and the payment of premiums was abandoned after a few years' trial.

A small increase in work in 1912 and 1913 was caused by the manufacture of new guns and the relining of old ones for the Navy. Extra shifts were employed in the shops, and some difficulties arose in finding enough machinists who were sufficiently skilled for gun manufacture. A new type of 14-inch gun was developed at that time, intended for use at Manila Bay in the Philippine Islands and at the Panama Canal. These mammoth guns had a maximum range of a little over ten miles, and fired a 1,660 pound projectile. Larger sums were now authorized by Congress for the manufacture of guns, in keeping with a project inaugurated by the Ordnance Department in 1913. The plans called for sufficient arms, equipment, and ammunition to be kept on hand to equip an enlarged regular army and an enlarged organized militia, with a surplus for an addi-

tional volunteer force, which surplus was intended to be greater in the articles which took longer to make. Additional funds were devoted to the manufacture of field and siege guns. To carry on the work, extra shifts were employed in the shops throughout the year.

Early in 1915, the number of employees reached 657, and at the close of the fiscal year in June 1915, Colonel Gibson was able to report to the Ordnance Department that "more guns were completed during the year than during any previous year in the history of the gun factory." The most important items which were produced during that year were six 14-inch guns, five 12-inch mortars, two 4.7-inch mobile artillery guns, seventy-seven 4.7-inch mobile artillery howitzers, twenty-one 3.8-inch mobile artillery howitzers, and eighty-four 3-inch field guns, all for the army. Two 10-inch guns were also relined for the Army, and Navy work included five 14-inch guns, thirty-four 4-inch guns, and the relining of three 12-inch guns. Under manufacture, but not completed, were 205 more guns for the Army and Navy.

The costs of cannon rose, although Colonel Gibson had hoped that an increased volume of work would result in a lower cost per unit. He ascribed the higher prices to the fact that "the working conditions at this establishment during the past two or three years have been abnormal, due to the great amount of urgent work in the shops. This had involved not only the taking on of large numbers of new men and use of night shifts, but had made necessary the frequent changing of machinists from job to job with the view to expediting the completion of the most urgent work. With the large influx of new workmen unused to the high class of work required, the average times for operations have been greater than in former years when the work was done by experienced employees specially trained in this class of employment." In line with this, the Chief of Ordnance

stated that costs of products of all the arsenals had been raised when Congress passed an act "granting thirty days leave with pay to all employees of the Ordnance Department. In addition, they receive pay each year without work for seven legal holidays and for about eleven Saturday afternoons during the summer season. Therefore, under the new act, they will receive pay for some forty-two and one-half days a year without work. Under the rule of paying the same daily wage as that of the vicinity for work of like character, a government employee will receive about sixteen percent more pay for the time actually worked than a private employee, since the latter is paid only for actual time worked.

Surprisingly, work decreased at the Arsenal in 1916. Orders for guns were received less frequently and the force of employees dropped approximately twenty-five percent below that of the preceding year. In June 1916, there were 422 workers in the Arsenal, many of them new, and thus unskilled — a large number of the skilled workmen had resigned and accepted jobs with private munition manufacturers at higher wages. With the next year, however, the Arsenal began its first phases of wartime expansion. A national emergency declared in February 1917, brought about a gradual increase in the number of employees, and by the time the United States declared war on Germany in April, the total had progressed to 568. Plans made by the Ordnance Department for the arsenal showed the figure of 10,000 as the maximum when the peak of production was reached, but when the war ended in 19 months, the planned expansion was only half completed and the maximum number of employees was 5,000. This, of course, was the largest number who had been employed at Watervliet Arsenal up to this time. This was to be the most extensive war in which the Arsenal had played a part.

Chapter 8
World War One and The Long Armistice

The declaration of a national emergency brought about many immediate changes at Watervliet. The working hours changed from three eight-hour shifts to two ten-hour shifts, and strenuous efforts were made to add skilled machinists to the force. An employment department was created which thoroughly searched the surrounding area for the type of worker needed, while traveling agents were sent out to more distant districts in an effort to find men. Every national fraternity and benevolent society was asked to advertise for machinists in their periodicals in behalf of the Arsenal, and technical and illustrated journals were similarly employed. Appeals were made to draft boards to induct men on limited service to go "into direct government work on big guns."

The Arsenal was successful in getting men but it became apparent that the turnover was terrific. In July 1918, it was sixty-one percent. The average stay at the Arsenal was fifty-six calendar days. The two main reasons behind the rapid exodus were higher pay elsewhere and enlisting or being drafted into the armed forces. The Arsenal pay was no match to many of the private manu-

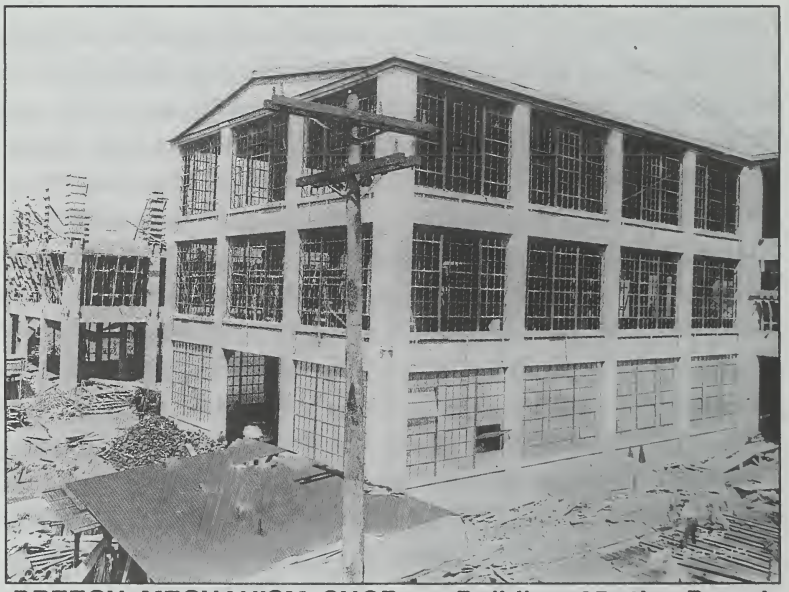
BUILDING 35—Construction crews put the finishing touches on a new gun shop, Building 35.

facturers in the area who offered not only higher wages but bonuses and other inducements. Wages for workers at the Arsenal below the rank of foreman ranged from the $8.00 a day paid to the skilled bricklayers to $3.20 a day for unskilled laborers. This was for an eight-hour day, five and one-half days a week, with time and one-half for overtime. Three general increases in pay were granted in the first year of the war, each for ten percent, in September 1917, and January and May of 1918. The monthly payroll rose from $42,218 in April 1917 to $547,769 in November 1918. In July of 1918, the Arsenal had asked that only 453 men out of the 3400 employees be deferred. When the rate of procurment of labor to replace these men fell seriously below the actual need, all the existing agencies for employing workmen proving inadequate, the Arsenal, in the fall of 1918, placed its hopes on a system of industrial furloughs for soldiers.

Colonel Gibson left the Arsenal in February 1918 to

serve on the Priorities Committee representing the Ordnance Department in Washington, and retired from the service in 1920. Newspapers in the Arsenal vicinity recorded the transfer and in praise of the officer who had commanded the Arsenal for ten years reported: "His habits of courtesy and kindliness brought him the regard and esteem of all, and never was a commandant at Watervliet Arsenal more generally popular." His successor was Colonel John E. Munroe, who was in command until September 1918.

The eight months of Colonel Munroe's command were difficult ones — morale was extremely low because of the continual influx of new personnel who had to be adjusted, and the workmen were taunted by outsiders with being "draft dodgers." A great deal of work was construction of builidngs, so that the employees felt that they were not making an immediate contribuiton to the war effort. Speaking of the whole



BREECH MECHANISM SHOP — Building 25, the Breech Mechanism Shop, takes shape in 1918.

year from July 1917 to July 1918, Colonel Munroe stated: "The salient feature of the past year's history of the Arsenal has been the change of the manufacturing plant from what was virtually a jobbing shop to a works desinged for quantity production. In spite of the rapid development reported, the year has been on the whole, one of preparation for larger service rather than of actual accomplishment."

The changeover to mass production called for a large construction program. The aggregate floor space of the Arsenal was more than doubled in the fiscal year ending in July 1918, and the total amount spent or obligated in that time for construction, equipment, and maintenance projects was $12,803,500. The most ambitious undertaking was a new gun shop, 200 feet by 600 feet, costing $812,000, and designed for an output of four 240mm howitzers and two 155mm guns per day. This shop was officially called the GF shop, but was generally referred to as "Shop 35." A liner shop which mea-

FIRE HOUSE — The firefighting staff grew rapidly as new buildings were constructed. New fire engines are displayed outside the firehouse in 1918.

sured 200 by 500 feet was built for the production of liners for shipment abroad for the purpose of relining the large caliber guns at ordnance depots, and cost $554,000. The third most important building erected was the Breech Mechanism Shop, which had a working area of 140,400 square feet on three floors, and cost $485,000. Some smaller buildings also went up — a heating plant, carpenter shop, cantonments, stockrooms, storehouses, cafeteria, brass foundry, blacksmith shop, and pump house. The main office building was greatly enlarged and altered at a cost of over $90,000.

In addition to the work on buildings, about 8,600 feet of concrete roads were constructed inside the Arsenal walls, and the portion of Broadway in front of the Arsenal grounds was straightened and paved, with granite blocks laid in concrete. Many new water pipes and sewer lines were laid, and gas was piped to the officers' quarters. A new dynamo room was installed to convert the alternating current received from the power company to direct current, which was required for lighting and power in "Shop 35." The heating systems were all overhauled and rearranged, and new insulation was applied to the underground steam lines. The post telephone system was supplanted by an automatic system with a capacity of two hundred stations. Considering the labor problems of the time, the accomplishments were spectacular.

The first, and probably the most unusual, piece of land added to the Arsenal grounds since 1869 was purchased in 1918, when the city of Watervliet sold an old burying ground to the United States for $1,000. The bodies were removed from the one and one-half acres located south of the South Wing of the Seacoast Cannon Shop to other cemeteries, and the land was used to improve the railroad facilities for the shops.

In order to protect the many new buildings, new fire apparatus was required. Until April 1918, the firefighting

equipment consisted of hand-drawn engines manned by the soldiers of the Arsenal. A motor-driven and operated fire engine and a motorized chemical engine were installed and a force of twelve regular firemen were constantly on duty from this date. Plant protection was also required and was delegated to the regular ordnance detachment of enlisted men consisting of fifty-five men at the beginning of the war. As the plant rapidly expanded, civilian guards were hired and by the summer of 1918, they numbered 105! In addition, two infantry companies consisting of five officers and 211 men were assigned to the Arsenal guard. These companies were transferred in October 1917, and replaced with detachments of about thirty-four soldiers. In September 1918, two companies of six officers and 340 men took over the job. There was no sabotage or treason at the Arsenal during the war, although an exciting "spy scare" occurred in December 1917.

A man claiming to be a French army officer and employed in the drafting room was arrested under the Espionage Act. The United States Commissioner who made the arrest stated that the alleged French officer had received many favors and the freedom of the Arsenal, and had carried drawings outside the walls with the permission of Colonel Gibson, the Commanding Officer. Since it could not be proved that the man had passed the drawings on to an enemy agent, he was discharged, but the Watervliet Arsenal received a public tongue-lashing, from the Commissioner, who chided: "Once having a permit from the commandant, it would seem that any employee could walk past the guard with all the plans and sketches he was physcially able to carry. This is an astounding condition of affairs and will be brought to the attention of the War Department."

At one time there were eighty-seven officers and almost eight hundred soldiers stationed at the Arsenal, the majority of whom were en-

rolled in the Cannon Relining School, which was one of the important undertakings of the post. It was established in December 1917, and continued throughout the war, sending one detachment of 123 men overseas in May 1918, and another in September of the same year. The men alternated a week of classwork with a week of actual experience in the shops, with the ultimate aim of being trained well enough to be prepared to organize and operate an American ordnance base depot in France to keep the American guns in repair. Liners to be installed abroad were also to be made at Watervliet, but none was ever shipped. Another school maintained was a supply school for officers commissioned from civil life. It was organized in June 1917, but was transferred to Camp Meade in December of that same year. The Supply School operated in connection with the general supply ordnance depot which had been set up at the Arsenal a

APPRENTICE TRAINING — Apprentices study math, an integral part of the gunmaking profession.

month after the United States entered the war. In September, the Arsenal's Supply Division was completely separated from the other post activities except in the matter of making disbursements. The Apprentice School, a permanent institution at the Arsenal, was enlarged and training was intensified for the apprentice machinists. The difficulties met by the Arsenal in hiring machinists of high skill increased the importance of its own school, where boys were trained in the special art of gunmaking. A school for training civilian assistant inspectors of cannon and artillery ammunition steel was also operating.

Colonel Charles G. Mettler arrived September 3, 1918, to take command of the post and set to work with tremendous enthusiasm and energy to improve the spirit and raise the sagging morale of the employees. He initiated an extensive publicity campaign regarding the gun factory, and established a crowded recreational program for all employees. The Governor of New York State gave an encouraging speech to the workmen. Other visitors during the autumn of 1918 came — newspaper men, clergy, representatives of the Chamber of Commerce and Rotary Club — and were informed by Colonel Mettler that the Arsenal was doing the best that could be accomplished under the circumstances, with the scarcity of skilled machinists and lack of forgings. He earnestly requested that the Arsenal no longer be referred to as "Slackerville" or "Loafers' Paradise," and particularly resented the trolley motormen who, when stopping at the Arsenal gates, called out: "All out for the Young Ladies Seminary!"

The Fourth Liberty Loan Drive was launched that fall and was promoted vigorously at the Arsenal. The new Breech Mechanism building was almost completed and was officially opened with a dance for the employees and their friends. An Arsenal band was organized. A weekly newspaper was published for a few months until an order from the War De-

partment prohibited its issue. Only a serious epidemic of influenza early in October was able to halt the many employees' meetings for a short time. Inner cooperation and enthusiasm among the workers began to take the place of the former apathy.

A housing shortage in the area complicated the labor situation throughout the war. Troy, Watervliet, and Albany were surveyed in 1918 to find what quarters were available for Arsenal employees. Colonel Mettler wrote letters which were read in all the churches in those cities, asking that "patriotic householders throw open their homes to Arsenal workers, particularly men with wives and children." The United States Housing Corporation was about to enter upon a larger building program on land purchased just south of the Arsenal grounds, when the Armistice was signed. Bids had been received the first of November for the construction of seventy-three houses and a hotel, but with the end of the war, the program was canceled. Efforts had also been made to induce Albany and Troy to undertake independent housing programs, but the cities were unwilling to act without government assistance.

The Supply Depot was charged, during the war, with the supply of Camps Devens, Dix, Upton, Meade, and Lee. At the beginning of the war, about 100,000 Krag rifles and carbines were overhauled and cleaned at the Depot, most of which went to camps for training new soldiers. A group of approximately fifty men was constantly engaged in cleaning and repairing equipment for eighteen months. In addition to this establishment on the Arsenal grounds, the Arsenal operated the Troy Ordnance Depot located in a building directly across the Hudson River, which employed from two hundred fifty to three hundred people.

A false report on November 7, 1918, that an Armistice had been signed created a jubilant celebration at Watervliet Arsenal. Led by the Arsenal band, crowds of employees marched around

the post, and that Thursday evening they held another demonstation marching to Troy bearing banners proclaiming "Arsenal Guns Beat the Huns," "We Made the Tools that Made the Kaiser Crazy," or "We Took the Germ out of Germany." On Monday, November 11, when the real armistice was signed, the same crowd went wild with delight and all work was suspended. A salute of forty-eight guns was fired, the workers had spontaneous parades all day long, sang, shouted, and formed lines of as many as two thousand persons to parade. Some just walked right out the gates, never returning for their tools or their pay. Colonel Mettler added a serious note to the proceedings with his speech, in which he cautioned: "Just because armistices between the warring powers in Europe and between ourselves and Germany and Austria have been signed is no reason to think that war work is over. One of the biggest jobs in the history of the world is now before us — that of readjusting the life of the world to peace conditions after many years of war."

The Watervliet Arsenal had produced during the year 1918 a total of 465 guns. According to a report made by the Assistant Secretary of War, Benedict Crowell, there had been completed at the armistice two 240mm guns, eighteen 155mm guns, ninety-three 4.7 inch guns, Model 1906, and one hundred and sixty-one of the 75mm guns, Model 1916. A few other guns of smaller caliber and four cannon of from 12-inch to 16-inch caliber completed the contribution of the Army Ordnance. The total expenditures during the war, from April 7, 1917, to November 30, 1918, amounted to $17,145,228.10, of which $4,375,832.39 were wages.

The year that followed war was the most enjoyable in the history of the post for the workers, and in the campaign to "keep up the morale of the workers even though the war has ended," the Watervliet Arsenal began to assume the delightful air of a country club. The Command-

WWI PRODUCTION — Guns await shipment from Building 110 in support of the war. In 1918, 465 guns were produced.

ing Officer reported that "the recreational and social needs and desires of the employees received great attention," and the activities seemed to center around the new cafeteria building and the Recreation Building which had been constructed by connecting two canton-ments formerly used for the post soldiers. The noon hour was filled almost daily with free motion pictures, dances, "sings", luncheons and pep talks for some or all of the employees. A typical program of a week's activities in the fall of 1919 lists from Monday to Friday at noon: Band concert and dancing, lecture on "Practical Education," a "community sing," an illustrated talk on "How Automobilies are Made," and a dance! The program also planned afternoon recreation: "Every afternoon after work the football team will spend an hour on the gridiron and there will be soccer on Saturday afternoon and rugby on Sunday afternoon." The evenings were well filled with dances, parties, and dinners. The Liner Shop entertained 1,000

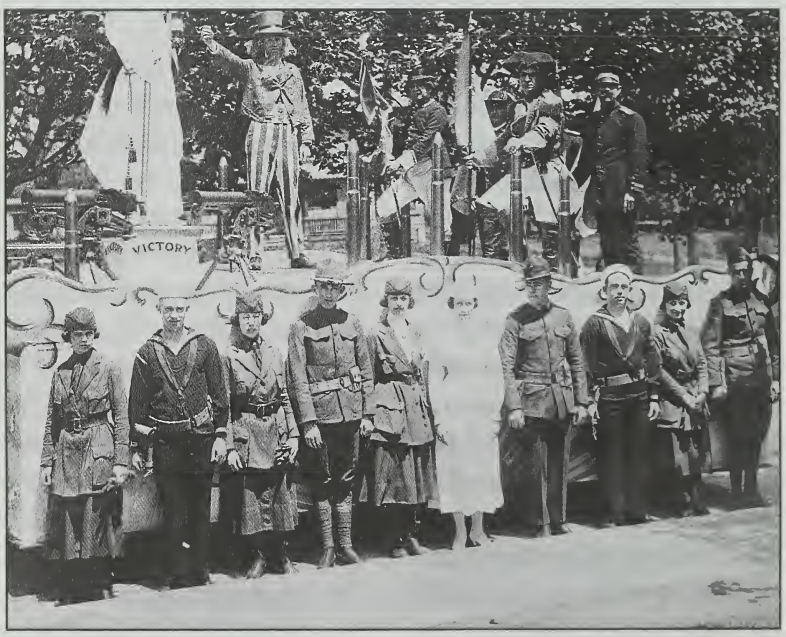
MAY DAY FETE — Two thousand celebrants mark the end of World War I. More than 20,000 witnessed the May 1919 fete.

employees and members of their families with an elaborate program, which is an indication of the general run of affairs. In the spring of 1919, a baseball diamond and ten tennis courts were laid out for those interested in athletics. An elaborate May Day Fete, in which two thousand took part and which twenty thousand witnessed, was presented. Many prominant personages visited the post in the months of general relaxation following the war. General John J. Pershing inspected the shops, accompanied by a large staff including his aide-de-camp, Colonel George C. Marshall. Governor Alfred E. Smith and a French ordnance mission were among the visitors and Franklin D. Roosevelt, the Assistant Secretary of the Navy, was welcomed with a fifteen-gun salute when he arrived for a tour of the shops.

When Colonel J. Walker Benet arrived on March 11, 1919, to take command of the Arsenal, he was serenaded by the post band and honored at many social functions. Colonel Benet had been sta-

tioned at Watervliet from 1899 to 1904, and had been responsible for the supervision and construction of all field guns manufactured in the field gun shop which was new at that time. He had also been charged with tests and experiments of various designs of firing mechanisms, and his excellent background and long experience in gunmaking were valuable to the Arsenal at a time when the shops were just beginning the mass production of guns. Colonel Mettler continued at the Arsenal as executive officer for a few months, and was transferred during the summer following a round of farewell parties which exemplified his tremendous personal popularity among the employees.

In Colonel Benet's annual report to the Chief of Ordnance at the close of the fiscal year, June 30, 1919, covering the entire war period, a



VICTORY — Uncle Sam joins Allies on May Fete float in 1919.

comprehensive outline of the war activity is presented. He stated that the expenditures from the beginning of the war to July 1919 came to a total of $25,367,777.78, orders completed consisted of 1,066 guns of all calibers, 187 guns and howitzers had been modified or relined, and 161,662 spare parts had been manufactured. He pointed out that "prior to the period covered by this report, cannon production at the Arsenal was much hampered by want of proper machine tools. Beginning in March 1917, a program of installation of up-to-date machine tools was inaugurated and during the period covered by this report, has been completed to the point where the cost of production has been universally reduced, and in many cases as much as two hundred percent.

"The history of the Arsenal during the year falls into periods: first, that from July 1 to November 30, 1918, and the second from December 1, 1918 to June 30, 1919. The first period was one of intense and ocncentrated effort to work to the utmost of the Arsenal's capacity such shops as were fully equipped and to put on the fullest quantity-production basis all other shops that had been authorized and built and of which the equipment was being put into use as rapidly as it was recieved and could be installed. Beside the regular day shifts working overtime, nearly one-fifth of the employees were organized into night shifts and about one-tenth worked on Sunday, all working overtime whenever needed to insure the continuous operation and production of the entire machinery equipment.

"Four days after the Armistice of November 11, 1918, under orders received from the Chief of Ordnance, all Sunday and overtime work was discontinued and between November 15 and December 1, under similar orders, the night shifts were reduced. Many of the men were discharged and the most valuable ones transferred to the day shifts to replace numerous separations which took place in the day forces.

These separations by the end of January aggregated 1075. Most of them were voluntary, being composed in part of workers attracted by the wartime rates of pay, who left when overtime ceased, hoping to get elsewhere as good wages as they had received at the Arsenal. Others were skilled workmen who had come from their homes elsewhere to help win the war and returned to their homes when that work was done.

"The second period covers from December 1, 1918, when the orders for cessation of overtime and night work had been complied with, to June 30, 1919. This period was one of a slow reduction in the forces to comply with the reduction in the unfilled orders that were made from time to time by the Ordnance Department. Numerous radical reductions in personnel were made throughout June, the total separation during the month being 963. In the first period, the number of officers present increased from 32 to 46; and in the second period it decreased to 18. The number of employees in the first period increased from 3563 at the end of June 1918 to 5126 in November. In the second period, this number was reduced to 3625 in April 1919. The monthly payroll in the first period increased from $371,889 from July 1918, to $547,769 for November 1918, which was the maximum. It fell in March 1919 to $375,581. The total monthly expenditures in the first period rose from $1,525,814 in July, to $2,096,246 in November 1918. In the second period they fell by June 1919 to $579,205.

"The second period was also one of constructive planning for the Arsenal's future. This followed its designation by the Ordnance Department as the plant to superintend the final stages of all types of cannon and to modify and perfect their designs in accordance with the results of proofs and tests and to provide the necessary jigs, fixtures and machines for the manufacture of the adopted desings and generally to act

as the center for the cannon industry and as the mainstay of the country for the production of cannon in time of war, including putting into prompt operation all gun plants held in ordinary as well as other private plants which it would be necessary to instruct and equip. For the latter purpose, the Facilities Division was organized at the Arsenal.

"The Facilities Division will have charge of organizing the cannon industry to cover the manufacture of all cannon required by the United States in time of war, considering an army of 4,000,000 men to be organized and equipped within one year. It will make a complete digest of the reports from the Arsenal on the requirements of the cannon industry, and determine the exact quantity for instruction purposes, for providing a reserve for a standing army and providing cannon for instruction and experimental purposes at the Arsenal. Each caliber will be produced at the Arsenal in the smallest quantity which will demonstrate the production methods. Whenever the Arsenal units will not provide sufficient cannon for a complete army, the private plants outlined in the report of the Artillery Division Board will be utilized to supplement this production to provide the total quantity. Detailed plans have been completed and drawn up for an 18-inch gun shop of a capacity sufficient to manufacture twenty-four 18-inch guns a year. This shop is to be located on the additional thirty-four acres of land adjoining the Arsenal on the west, the purchase of which has been authorized. The estimated cost of the 24 guns a year project is approximately $15,000,000. Funds have not yet been secured for this project and no work has been undertaken as yet on it."

Colonel Benet was calmly reporting plans that had been screaming headlines in the vicinity newspapers two weeks after the armistice had been signed. Quoting Colonel Mettler, who was then commanding officer, the newspapers predicted that the Watervliet Arsenal was to be turned into "the greatest gun-

building establishment in the world" and that "the prospect is to keep at least 4,000 men permanently at the Arsenal." War was still in the minds of the public — representatives from the district to Congress echoed the same grandiose plans for expansion of the Arsenal; "It is learned today that the peace program will be only a little less extensive than that which would have been regarded as a war necessity, providing the war continued. It is understood that other arsenals in the country will either be eliminated or their work greatly restricted and the army will concentrate its activities largely at Watervliet....No less than $20,000,000 will be spent by the government on the Watervliet Arsenal." The citizens of the vicinity were becoming enthusiastically friendly toward the Arsenal. The newspapers recommended that the stone wall surrounding the grounds be torn down and replaced with a picket fence, stating that "a desire to divest the post of the character of a fortress hidden from the outside world, and to make it a part of the city of Watervliet and not a sequestered entity, which the wall tended to make of it, is said to have figured in the determination to make the change." This plan, however, with many another, never went beyond presentation in print.

One plan which did go into action was the acquisition of thirty-four acres adjoining the grounds on the northwest, which purchase caused a great deal of trouble. The fifty-odd houses on the plot caused most of the grief entailed. The War Department authorized the procurement of the land in April 1919, and a few months later an allotment of $300,000 was made to the Arsenal for the purchase. Since the land was divided into lots and was owned by many individuals, a long period of searching for titles was required, during which time the houses on the land had to be vacated while the owners waited an indefintie time for their money. To aid the ejected householders, citizens of Troy and Waterlviet organized a purchasing company

entitled: "The Arsenal Extension Corporation." This company took options from the various owners of the lots and houses, and held the land until the United States was ready to buy from the company, and meanwhile continued search for the titles. Bills for the appraisals of the property and search for titles amounting to several thousand dollars were met by the Corporation, which also advanced ten percent of the purchase price to the orginal owners. By July 1919, Congress forbade the buying of any more land by the War Department, but, under pressure, reconsidered and permitted the purchase of the property for the Watervliet Arsenal. The transaction dragged on for almost five years, and then the land was sold at a considerable loss to the War Department.

A "Find Yourself Campaign" was waged at the Arsenal in the spring of 1919, which was a form of mass industrial education. A group of one hundred and thirty-five young men were questioned carefully to determine what they most wanted to learn and, after studying the answers, the Arsenal leaders organized a foreman's school and made plans for specialists, machine operators and vestibule schools. The Apprentice School was reorganized and revitalized, and the largest number up to that time — ninety-five — was enrolled. It was hoped that large classes in industrial education could be maintained, but lack of funds curtailed the plans by 1920.

Work on a 16-inch wire-wound gun which had been started in 1917 was continued during 1919, and about five hundred cannon were completed that year, of which 197 were 155-mm guns and 181 were 240-mm howitzers. Forgings for these guns had either been ordered or were on hand before the end of the war, and the Arsenal workshops were ready to go into mass production at the time the Armistice was signed. The Ordnance Department intended that the Arsenal should manufacture four of the 240-mm howitzers per day, and two of the 155-mm

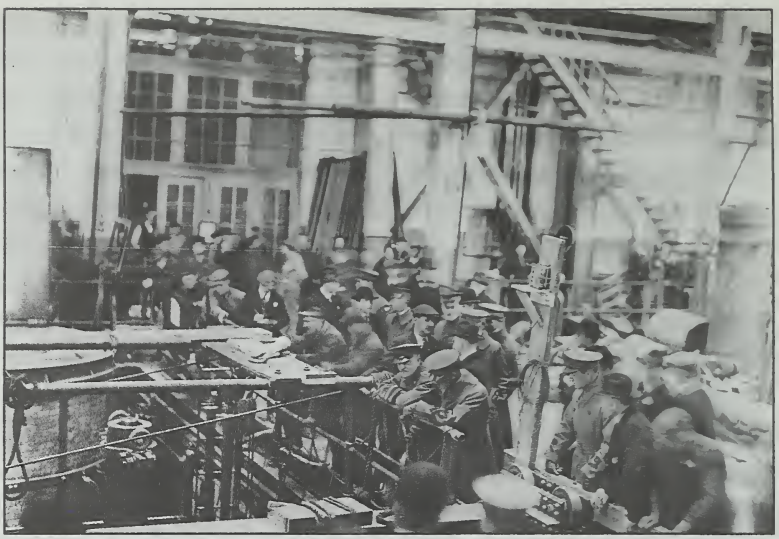
guns. There had been a delay in getting into production, however. The Secretary of State announced that "in numerous instances we were not able to secure complete drawings until months after we had entered the war, due to the practice of French manufacturing that intrusts numerous exact measurements to the memories of the mechanics working in their shops." Plans for the buildings, orders for machinery — nothing could go forward until the Ordnance men in the United States had received plans and had translated them. On November 7, 1918, the Arsenal had orders on hand for 1,160 howtizers of 240mm caliber and had contracted to reach an output of 100 cannon a month, with the last howitzer to be delivered not later than September 30, 1919. Two of them had been manufactured by November 11, 1918, but only one had been fitted with a carriage, and the orders were immediately cut so that the workshops produced only 303 howitzers by July 1, 1920.

When Colonel Benet made his annual report in June of 1920, he admitted that the preceding year had "been quiet compared with the previous season." The force of workers had been gradually diminished and it was now necessary to receive an increase in orders so that a further reduction would not have to be made. A series of noon meetings were held to duscuss ways to assure continued work in the shops, and a committee was sent to Washington concerning the problem. They had hoped to obtain orders from other government agencies, but the committee was unenthusiastically received by the Secretary of War who informed them that they "couldn't hope to turn the government arsenals into general industrial plants." The funds which Congress had appropriated a half year after the end of the war for the Arsenal ran out at the end of June and gloom settled over the plant. Approximately sixteen hundred employees, two-thirds of the force, were discharged on the first of July, followed two weeks later by two hundred

more. Washington had assured the commanding officer that at least 800 persons would comprise a permanent force, but by September there were only 550 left at the Arsenal.

The Facilities Division continued its work in 1920 of selecting and arranging the machines held by private manufacturers, and working out plans by which they could be quickly put into use in making big guns in case of an emergency. The allotment for 155-mm guns, 240-mm howtizers, 194-mm guns, 12-inch howitzers, 10-inch guns, 16-inch howitzers, and 14-inch guns was received at the Arsenal and the necessary changes to shops to facilitate their manufacture were made. Inspection and working gages numbering 35,935 and valued at $1,037,400 used for all the guns manufactured during the war were shipped to the Arsenal where they were inspected, checked and stored. During the following year, almost seven thousand more gages were received. Jigs, fixtures, and special tools requried in gun manufacture, except for those required by private manfuacturers, were shipped to the Arsenal, sorted, and stored for future use. The monetary value of the Arsenal, with its increased stores and shop alterations, was increased to $5,004,140. The productive capacity was also increased to an estimated 1165 guns per year. By the rearrangement of machinery and the replacement of obsolete and worn-out machinery, a large quantity of surplus machine tool equipment was left, which was sold for about $900,000.

Alterations were made to the heavy field cannon building at a cost of $92,000 to provide facilities for manufacturing 194-mm guns. The south wing of the Seacoast Cannon Shop was extended 180 feet, with the ocntract for the construction amounting to $89,500. Another important project was the modification and enlargement of the shrink pit in the Seacoast Cannon Shop. The 72-foot-deep oil-burning furnace was found to be unserviceable and was replaced by an electric



PERSHING IN SHOPS — Gen. John J. Pershing inspects new shrink pit in Seacoast Gun Shop during post-war visit.

furnace which was followed by a second furnace. The first shrink made using electricity as the method of heating took place April 16, 1920.

All materials in Arsenal storehouses, excepting those for the manufacture of cannon, were finally cleared out, and Colonel Benet was well pleased that all small arms and ammunition had been shipped to other arsneals by the autumn of 1919. At that time, there was violent labor unrest in the nation, and the Ordnance Department had visions of mobs storming the Arsenal in search of small

INSPECTION — Gen. Pershing inspects the troops during arsenal visit.

arms. An offer was made by the War Department to send troops to protect the government property, but Colonel Benet discouraged the idea, informing the powers-that-be that the vicinity was unusually peaceful and the he would publicize the lack of rifles and ammunition stored at the Arsenal.

The Arsenal itself was indeed peaceful at this time. With the reduction in the number of employees, the need for guards was decreased and in July 1920, there were only twenty-four men on guard, which number was retained during the next fiscal year. Five Army Officers were at the post, many of whom had been reduced in rank when the army was reorganized in 1920 — some from Lieutenant Colonels to Captains.

When he reached retirement age, Colonel Benet officially ended his term as commanding officer on July 16, 1921, although he left the Arsenal May 28, on a terminal leave of absence. Not long after this, he died. Colonel Benet was on e of a distinguished family. His father, General S. V. Benet, was Chief of Ordnance for seventeen years, and his two sons, Stephen Vincent and William Rose, became prominent authors. He was greatly beloved by the entire personnel of Waterlviet Arsenal, for he was a man who made an art of living—power and money held no interest for him and his enthusiasm and energy were reserved for friendly living with the world and loving devotion to his family.

Lieutenant Colonel William I. Westervelt, who succeeded Colonel Benet, had served as an assistant officer at the Arsenal since 1919, and was the first subordinate officer to be promoted to commanding officer. Colonel Westervelt's service in the army had been divided between Artillery and Ordnance. He served as a Brigadier General in command of the First Army artillery and later as assistant to the Chief of Artillery in World War I, and after the armistice he was made president of the Westervelt Board, which made recommendations as to the artil-

lery equipment of the field army. The Board traveled extensively in Italy, France, England and occupied Germany, consulting with representatives of the governments. When its owrk had been completed, Colonel Westervelt was made a member of the War Plans Division and of the joint Army and Navy Planning Committees. He was the author of a number of books on artillery, explosives, and ordnance engineering, and had been decorated serveral times, receiving the Distinguished Service Medal and the French Legion of Honor, among other awards. When he was assigned to Watervliet Arsenal, he took over the difficult job of super-intendent of production, which he held for two years until he became Commanding Officer.

Naturally jolly and good natured, Colonel Westervelt was faced with the unpleasant task of discharging hundreds of employees in the two years that he was commanding. Diplomatically trying to soften the blow of the discharges by personal talks, he found that he was sometimes rewarded with the personal dislike of the worker who was leaving — losing jobs is a highly personal matter and it is logical that the jobless would place the blame on the flesh-and-blood Commanding Officer rather than on Congress which had ceased to appropriate large funds for government arsenals. When he was transferred in the fall of 1923, there were only 198 Arsenal employees, as compared with 550 when he assumed command.

Each year the total number of guns manufactured in the shops also dropped lower. During the twelve months which ended on June 30, 1921, there were thirty-five guns turned out and in the fiscal year of 1923, the sum total of six were manufactured. With the diminishing rate of work, apprentices could not be satisfactorily placed in the shops, so that the last of the apprentices had either graduated or resigned by 1923, and the Apprentice School was abolished. Industrial education of disabled

veterans of World War Iwas, however, continued until 1924 and a group of about thirty veterans were trained each year to be machinists, draftmen, or electricians until this school was disbanded by the Veterans Bureau. Another end to a part of the Arsenal came in 1922 when the Erie Canal, which had played an important part in the life of the Arsenal since 1825, was officially abandoned by the Canal Board. Arsenal authorities went through considerable litigation to clear the title to the 4.88 acres of land which was left inside the Arsenal when the canal was drained. One-third of the land was already vested in the United States, but immediate action was taken to prevent any future question as to the title. An appraisal value of $7,000 was placed on the land, but New York State, which had owned the land for almost one hudnred years, authorized the conveyance to the United States for one dollar. The City of Watervliet wanted the abandoned canal bed to make it into a highway, which matter was pending until 1939 when the Ordnance Department restricted the Arsenal grounds and built high walls across the entrance and exit of the old canal channel.

The Salvage Section was the only department of the Arsenal which kept moderately busy during the early 1920's. Surplus material valued at approximately $1,500,000 was disposed of during the fiscal year ending in June, 1923. Part of this material was transferred to other government agencies, and some was sold at auction or by sealed bid sales. The social activities of the personnel left at Watervliet dwindled, shrank, and finally died. The forty-two piece band which had led the Armistice Day marchers diminished to a six-piece orchestra, which was automatically disbanded when five members were separated. The cafeteria, which had been the center for many parties, dinners, and luncheons, was closed. The ten fine tennis courts stood empty, and were finally covered with weeds; the baseball diamond was

used by various industrial teams and local schools. The only active organization was the Twenty Year Club, composed of Arsenal employees who had had twenty or more years of service at the Arsenal, which had been organized in 1919. The number of civilian guards was reduced to three on day duty, and the rest of the necessary guard duty was performed by the enlisted men.

Colonel Westervelt left the Watervliet Arsenal on September 1, 1923, and went to Europe, where he acted as a technical adviser for the War Department for four years. Retiring in 1927 after thirty years' service, he left the army to become a research director for Sears, Roebuck and Company. During the depression he was called to Washington and made a director of one of the important branches of the Agricultural Adjustment Administration and for a few months in 1940, he was called back for active duty as a Brigadier General, which rank he held in World War I.

A month after Colonel Westervelt's departure, Colonel Edwin D. Bricker took command of the post. From 1910 to 1915, Colonel Bricker, then a major, had served at Watervliet as an assistant officer and was remembered as a severe disciplinarian. As commanding officer, he made an excellent executive — his dominating personality was an important factor in keeping the Arsenal alive in the six slow years from 1923 to 1929 when the number of employees dropped to the lowest point since the gun plant had been established. By the fall of 1926, he had jurisdiction over a mere 121 employees. He went to Washington and argued against closing the shops. He took a long view on the ordnance situation and presented his ideas on the subject to the Ordnance Department at every opportunity. Some of his well-chosen and logical arguments are able to be quoted: "The figures indicate the small number of mechanics actually engaged in productive work in the construction of cannon. Considering the highly spe-

cialized nature of this work, the years of training required to master the details, the fact that no civilian concerns are equipped for this work or have an organiztaion of trained personnel for undertaking it, makes the situation serious. The gun factory at the Washington Navy Yard is the only other plant in the country now engaged in gun construction.

"The disturbing feature about this situation is the fact that the old skilled mechanics are gradually dying or being retired and no young men are being trained to replace them. There remains at present this small nucleus hardly sufficient to properly expand the activities of the Arsenal in case of an emergency, leaving no one to be sent to private concerns who have been allocated orders for cannon, to assist them in starting work and in training their personnel. It is believed that the danger point has been reached, that any further drastic reduction in personnel at this establishment will have the effect of destroying the gun-making industry as far as the Army is concerned.

"In the opinion of this Arsenal, a minimum force of 100 machinists and toolmakers is the least that should be carried in this plant in times of peace. This will give a nucleus for our own expansion and sufficient trained civilians for key postions in other plants that will be engaged in the manufacture of cannon."

Colonel Bricker's plea that the practical knowledge of gun-making be kept alive was renewed each year in his annual report to the Ordnance Department. There was an average of forty-one machinists and toolmakers in the fiscal year 1926, and the last year of Colonel Bricker's command, 1929, the average had risen to sixty-nine. The minimum number desired had not been reached, but the critical situation had been slightly alleviated. The most careful economy was practiced in order to make the small funds stretch as far as possible. The entire Arsenal closed for a month's vacation in July. All peacetime manufacturing activities were

concentrated in one end of the Seacoast Cannon Shop and that part of the shop was partitioned off so the whole builidng would not need to be heated. The other buildings were put into a standby conditon, with the unheated structures and machines protected against rust, dust, and general deterioration. Throughout the New England states, New York and Pennsylvania, advertisements were published in an attempt to rent the Breech Mechanism or other buildings, but no bids were received from private manufacturers. As another new method of saving money, Colonel Bricker urged the Ordnance Department to cease buying lots on the Arsenal extension which had been initiated in 1919. For the necessary police and maintenance of the buildings, grounds, and water and gas facilities, $5,000 a year was required — since plans had been abandoned to build an 18-inch cannon shop on the land, the sum was considered an unnecessary extravagance. Acquisition of titles to the lots was discontinued in 1925, and most of the land was sold at public auction in the autumn of 1926, with the remainder going in 1927.

Another land problem was created by the empty canal bed. A number of sewers emptied into the canal, which were relaid to drain into the Hudson River but, even after this revision, the canal bed had an accumulation of filth which formed an unsanitary stagnant ditch, a breeding place for mosquitos. It was arranged with the Department of Engineers, which was dredging the Hudson River in the vicinity, to pump the gravel dredged from the river bed into the canal bed. However, the Ordnance Department would not give the $15,000 necessary to haul the gravel into the Arsenal, and for seventeen years occupants of the post suffered from the canal stench and mosquitos.

By 1926 even closer economy was found necessary. One measure taken was the placing of all Arsenal typists and stenographers in a "pool," subject to call by the various offices only when there was urgent work to be

ORDNANCE DETACHMENT — The 19th Ordnance Detachment is reduced in post-war years.

done. The Arsenal War Plans were practically complete that year, but were all on paper, and no money was spect on concrete accomplishments. To keep alive an interest in ordnance work, Colonel Bricker started a series of meetings for reserve officers, and prepared and sent a monthly bulletin to each man to keep him informed on gun manufacture, development, and industrial preparedness. At the same time, the 19th Ordnance Company which was stationed on the post, was reduced in strength to thirty-seven men, while the Quartermaster and Medical detachments were given an average strength of three men. The shops and other buildings which had been put in a standby conditon five year earlier, were rapidly deteriorating, as very limited funds were available for maintenance. Roofs leaked, windows were broken, steel doors and window sashes were rusting. All the spindles of the stored machinery needed to be turned and re-oiled. After repeated requests, funds were

obtained in 1929 for the care of the machines, but none for the repair of buildings. A slight increase in personnel was made in 1929, when an order for a number of 8-inch guns was received from the Navy Department. Colonel Bricker had been successful in convincing his Washington superiors that the guns should be made at the Watervliet Arsenal. That same year he left for Washington himself. On July 30, he becamse Assistant Chief of Ordnance, with the rank of Brigadier General, which position he held for four years. In 1939, on reaching retirement age, he left the service but was called back to active duty in 1940.

The new commanding officer who arrived September 9, 1929, was Colonel Herman W. Schull. Born in England, he came to the United States and was appointeed to the United States Military Academy from South Dakota, graduating in 1899. During World War I, he served in the Gun Division, Office of the Chief of Ordnance, until 1918. One of the pioneer officers in the establishment of the Aberdeen Proving Ground, he commanded that post for a few years and for five years previous to coming to Watervliet, he had been commanding officer of the Springfield Armory.

The company of enlisted men stationed at the Arsenal was transferred to Aberdeen Proving Ground in the spring of 1930, leaving only six enlisted men on detached duty with the Ordnance and Medical Departments and the Quartermaster Corps. The large stone barracks which had been occupied by Ordnance companies since 1843 was closed until World War II, when it was altered to make offices for the Works Manager. The commissary and quartermaster storehouse, built in 1849 as an ammunition laboratory, was closed until 1939 when it was used as living quarters for reserve officers on two weeks' active duty at the Arsenal.

With a slight increase of orders, the number of employees at the Arsenal rose to

223 by June 1930. Economic depression was reflected in the steady daily flow of applicants for all kinds of work at the gun factory — in preceding years only a few persons had applied for work, but in the fiscal year 1930 there were about 3,000 asking for work which was not available. However, apprentice instruction was re-established in that year, and ten students were chosen under the civil service regulations to start training in August 1939. To provide education and recreation for the shop personnel during the noon hour, moving picture programs were shown once a week, and were well attended.

In the year and one-half that Colonel Schull commadned the Watervliet Arsenal, the roll of employees hovered around 200, although more and more people sought employment. In the fiscal year 1931, 3,600 applicants for jobs came to the Arsenal, but since production was at a minimum, few were hired. In 1931, sixty-four guns, all small caliber, were made in the one gun shop which was operating. The only other activity was a small amount of repair work on buildings which were in urgent need of attention.

Colonel Schull left the Arsenal February 28, 1932, to become Commanding Officer of Rock Island Arsenal. Later, he became Assistant to the Chief of Ordnance and Chief of the Manufacturing Service, and was promoted to the rank of Brigadier General, which position he held until he retired from active service at his own request, after more than forty-three years in the Army. He was succeeded at the Watervliet Arsenal by Major Charles A. Schimelfenig, who had been the second-ranking officer at the post. A rather small man with a peculiar high-pitched voice, he was very democratic and was well liked by the Arsenal workers. His command lasted for only five months and ended in tragedy. While waiting for his transfer orders to another post, both he and his wife were instantly killed by an automobile as they were crossing a street in Troy.

Major Schimelfenig was a brilliant and promising Ordnance officer, and his death at the age of 45 was a loss to the Ordnance Department.

Colonel Gilbert H. Stewart held command of the Arsenal from August 1, 1932 to September 12, 1938. Quiet and mild-mannered, Colonel Stewart was nevertheless friendly and was looked upon with liking and trust by the Arsenal employees. Before coming to Watervliet Arsenal, he had served in the Office of the Chief of Ordnance for a number of years and had commanded the Augusta Arsenal in Georgia and the Honolulu Ordnance Depot in Hawaii. He was one of the few commanding officers who had never been stationed previously at Watervliet.

During the early years of Colonel Stewart's command, the depression was felt more severely at the Arsenal. A four-day week was enforced in 1932, promotions were ruled out and the workers' pays were cut. Under the terms of the Economy Act of June 1932, an eight and one-third percent reduction in pay of all employees whose salaries exceeded $1000 a year was made. In order to spread employment, almost all the workers were furloughed one day each week from January to March 1933. A few months later the Arsenal returned to a five-day week, after a three-months' period in which a full working week was accompanied by a fifteen percent pay reduction for everyone.

Although Watervliet was the only Arsenal in the United States capable of producing cannon, agitation in 1932 was started to close the establishment. A prominent local pastor recommended that the vacant land on the Arsenal grounds should be used as "sites for the proposed new post office and for the long-awaited new high school." The most important plan was reported by the Troy Record. A Watervliet city official proposed a scheme to close the Arsenal and use the buildings for a Veterans' Hospital, which plan was strongly upheld, of course, by the local American Legion post. As they observed "the idle

buildings on the Arsenal grounds have probably seen their last active days unless the government makes some such use of them as the Watervliet post urges." The local newspaper followed the same line of thought as the Legionnaires, and announced in its editorial column that "the Arsenal has seen its best days as an Army post....It is merely existing and its existence is of no real service to the government under prevailing conditions." Trojans seemed to be more aware of the potential value of the cannon factory, and the Troy Record printed an excellent resume of the real worth of the establishment, both to Troy and to the Nation. Timeless in character, the reasons still hold true and will continue to do so:

"Established in 1813 it represents an investment of $21,000,000—an outgrowth of an initial expenditure of $50,000.

"It is the only arsenal in the United States capable of producing cannon.

"Abandonment of Watervliet Arsenal would destroy the usefulness of all other arsenals in the country.

"Required as the basis for the expansion of the gun-making industry in case of an emergency.

"From its force must be recruited specialists to instruct men or establish other plants for the manufacture of cannon, should a national crisis arise.

"Skilled workmen in the arsenal are just as necessary to the nation as is the maintenance of the Army Navy Reserve Corps as a preparedness measure."

The Arsenal is, naturally, important to Troy because of the amount of money it puts into circulation in the area, and the amount spent in the district for materials and upkeep. The Record went on to point out that it is "one of the chain of several arsenals linked together for national defense. Activities of the various arsenals do not overlap. The abandonment of one would destroy the usefulness of the others." Fortunately for the nation, all plans to kill the Arsenal as a gun plant failed, the far-sighted sound-

thinking citizens of the area undoubtedly helping to forestall drastic action.

A naval construction program planned late in 1932 furnished work for the Arsenal gun shops, with funds coming from the Public Works Administration. The number of workers rose to 470 in May 1934, and about one-half of the heavy field cannon shop GF, Shop 35, which had been in a stand-by condition for many years, was opened to make fifty 5-inch antiaircraft guns for the Navy and twelve 105-mm antiaircraft guns for the Army. Part of the work of relining one hundred 4-inch guns for the Navy was done in this building also.

Arsenal heads welcomed with open arms the assistance that the Civil Works Administration offered to accomplish a considerable amount of repair work — some to the builidngs had not been painted in fifteen years, and the CWA relaid Arsenal railroad tracks, repaired roofs, skylights, and foundations. The appearance of the post was thus improved, although the activity was still sluggish. Regular operations in the two shops which were open were not pressing, and a four, or sometimes five-day week was in effect. The chemical laboratory which had not been used in years was dismantled and the equipment and chemicals given to other arsenals.

Conditions at the Arsenal from 1935 to 1938 were on what might be considered a normal peacetime basis. The personnel averaged about 350, worked a forty-hour week, and produced about ninety guns and various parts each year. In 1935 an extra allotment of $353,000 was received for new machinery, and most of the work was transferred to Shop 35. Experimental work began again, with special attention paid to the possibility of broaching the rifling in cannon up to the 155 mm caliber, with the conventional type of broaches. By 1938, they achieved success in cutting the rifling time from about six hours to forty-five minutes, by using disc broaching to rifle 75 mm pack howtizers. During this same

WPA PROJECT — Painting of Octagonal Guard House was a 1936 WPA project.

period, the final finishing of cannon bores was changed from slow and difficult reaming to a honing process, in which the inside of the cannon was polished with revolving honing stones. About three hours was saved on each gun, and the finish was far superior to that obtained by reaming. Carbide tools were introduced to increase the production rates for various machining operations on cannon and breech mechanism parts.

Repair work started by the CWA was continued until World War II by the Works Progress Administration, another organization maintained by the Federal Government to give work to the unemployed. The Arsenal grounds, roads, buildings, and utilities were placed in better condition, although the commanding officer reported that the labor cost was much higher than if the repairs had been made by the more highly skilled Arsenal personnel. For a number of years, almost two hundred WPA workers were employed in the Arsenal.

Colonel Stewart left the Arsenal September 12, 1938, and assumed command of the Springfield Armory. Later he was promoted to Brigadier General, AUS, and he left the service in June 1942, upon reaching the retirement age. Colonel Richard H. Somers, who became commanding officer of the Watervliet Arsenal on November 14, 1938, held that position until the summer of 1940. Of Quaker ancestry, Colonel Somers was admired and respected for his fine character. Educated in country schools in New Jersey, he did not attend high school, but taught himself at home and passed the state examinations for teachers, which profes-

sion he followed for several years before receiving an appointment to the United States Military Academy. Always interested in education, he helped to plan the first courses for R.O.T.C. units, and taught at West Point

NEW FENCE — New sidewalks and fencing along Broadway were completed under WPA in 1936

for a while. Of medium height and stocky build, he had snapping brown eyes which testified to his occasional hot temper, although the Arsenal employees testified to his love of justice and keen sense of humor, and he ruled the Arsenal with a kindly manner and paternal attitude.

When Colonel Somers arrived at the Arsenal there were 350 employees, but by July 1939, the number had risen to 1,000 and when he left one year later, the figure had jumped to 1752. For the first time in its history, the Arsenal had begun to prepare for a war before the nation was actually involved. In the autumn of 1938, Prime Minister Chamberlain had returned to England from the Munich conference with Hitler and Mussolini, declaring that "there will be peace in our time." But the whole world was tense, waiting for the storm to break. Inevitably, it did break, suddenly and violently, on September 1, 1939, when Hitler's crack mechanized troops crashed into Poland. The lull in the fighting after Poland fell did not relax the nerves of the world which were keyed to absorb, without full realization, the lightning-quick occupation of Norway and Denmark by the Germans in April 1940, followed by their rapid crumpling of defenses in Holland, Belgium, and France. These events in Europe could not help but have repercussions in America and at the only army gun plant in the United States.

Only five commissioned officers were on duty at the Arsenal in July of 1939, and Colonel Somers requested that more officers be assigned to the post, advising the Ordnance Department that "under existing somewhat abnormal conditions, the Arsenal is felt to be distinctly understaffed as far as officers of the regular army service are concerned." However, there were not enough officers in the Ordnance Department at the time to permit a greater allotment for the Arsenal, and no more than four regular army officers were stationed at the post during the period of the na-

DRAFTING CLASS — The Apprentice School for machinists was reopened in 1939 with 45 apprentices.

tional emergency and World War II. The increased need for officers was adequately met by the assignment of reserve officers to extended active duty. When Colonel Somers left the Arsenal on July 17, 1940, there were six reserve officers on duty, and three reserve officers had received training in the shops for a two-week period during the summer of 1938. The first regular training school was held for reserve officers in the summer of 1939, with twenty-five in attendance. The WPA furnished labor and funds to remodel the RW Building so that it could be used as mess hall and sleeping quarters, and the classes were held in the Broadway Shops. A second training school was held in 1940. The Apprentice School for machinists was re-established in August, 1939, with an enrollment of forty-five for a four-year course. This school was confined to Building GB, the small gun shop, and adjacent office, and had two machine shop instructors, one technical instructor, and one in charge of shop.

The production rate was rising rapidly in the fiscal year which ended June 30, 1940, and 919 guns were made, as well as a large number of tubes and liners. Fifty 4-inch guns were made for the Navy in that year and many guns were adapted to a new caliber or were repaired. Coldworking of metals was begun in the spring of 1940, and elaborate equipment was installed in Building GF to convert forgings of low tensile strength to a higher tensile strength by the use of pressure. A metallurgical laboratory was set up in May 1939 to make tests on the steel used in manufacturing guns.

Late in 1939, the system of identification badges containing the picture, name, payroll number, and thumb print of the employee was put into force and by 1940 was rigidly established — no employee could enter or leave the arsenal without displaying his badge to an arsenal guard, and they were worn during working hours. Employees were well paid, and it was not difficult to obtain a working force. New machinists in 1940 received $6.96 per day to start with, which was raised to $7.68 after six months' probational service. The top rate for a machinist was $8.40; for a gage checker, $9.68; a mechanic helper from $4.72 to $6.00 a day, and the foremen received salaries of from $2,200 a year to $3,800.

Colonel Somers was transferred to the Office of the Chief of Ordnance in July 1940 and was promoted to the rank of Brigadier General. In 1942, he left the service, having reached the retirement age, became editor of Army Ordnance and later taught mathematics at Dartmouth College in line with his original occupation and vital interests. The Office of the Chief of Ordnance in turn yielded the new commanding officer in the person of Colonel Alexander G. Gillespie, who assumed command on July 19,1940, at the very beginning of wartime activity. His was to be a difficult job.

Chapter 9
World War II

With the increased complexity of modern warfare, came increased production and administrative problems. At the end of the month in which Colonel Gillespie had arrived at the Arsenal, he was called to Washington for a conference with the Chief of Ordnance and the Arsenal Commanders in the office of the Secretary of War. There the plans were laid for the tremendous expansion of Watervliet and other arsenals in the event of war. Three months after he had assumed command, Colonel Gillespie was promoted to the rank of Brigadier General in recognition of his previous fine record and in keeping with the tremendous job which he was undertaking. His background was of inestimable help—he knew Ordnance. As a graduate of the United States Military Academy in 1906, his military career began as a Second Lieutenant. He was also a graduate of the Coast Artillery School, the Command and General Staff School, and the Army War College. During World War I, he had served in France as division Ordnance Officer of the 86th Division and was on duty in the Ordnance repairs shops at Mehun, France. Later he was of the Sixth Corps Area, and Professor of

FDR VISIT — BG Gillespie, right, introduces Frank Miller, works manager, to President Roosevelt on Oct. 7, 1940.

Ordnance and the Science of Gunnery at West Point. From 1934 to 1937, he was in command of the Rock Island Arsenal, and was chief of the Artillery Division of the Industrial Division in the Office of the Chief of Ordnance until taking command at Watervliet. The only other officer to hold the rank of Brigidier General while in command was Peter Hagner, who received the promotion at the close of the Civil War but returned to the rank of Colonel when the Army was reorganized in 1870.

In August of 1940, action commenced. The number of employees began the first part of the steep climb, plans for new buildings and roads were made, and unused buildings were opened and made ready for work. The Liner Shop and the two top floors of the Breech Mechanism Building, which had been used as storehouses since World War I, were cleaned and fitted with machines. Seventy-five apprentices were enrolled in the Ap-

prentice School, joining the forty-five young men who had started to train a year earlier. The first Inspectors' course for thirteen men was completed in August 1940, and forty-nine more men enrolled for the second course. Training of gage checkers was started with the first Inspectors' Course. The peacetime forty-hour work week was abandoned and the advanced schedule of forty-eight hours of work per week took its place. President Roosevelt had proclaimed a state of partial emergency for the nation in September 1939, and the first peacetime conscription started in October 1940. Arsenal workers were given a few hours off to register for the draft. The Arsenal was visited that same month by the President himself, who, with Mrs. Roosevelt and Governor Lehman, inspected the shops and observed some of the finished products, under the guidance of the Commanding General and his staff.

Getting into production itself was only part of the task that faced the Arsenal—

BRIEFING — FDR is briefed during motorcade.

the other half was even more difficult and consisted of getting private manufacturers into production of cannon also. The War Plans so carefully worked out during the 1920's were of value in that the plans for production and methods of manufacture of cannon were immediately available to offer to commercial plants. Only the basic principles could be used, however, as the planners who produced the program had been unable to foresee the unparalleled quantities of cannon needed in modern warfare. As private manufacturers had no knowledge of gun making, it was not simply a matter of turning

over to them the orders for production—some companies learned quickly and well, while others were slow and made mistakes. As an example of one of the latter, the following teletype message was sent to the Chief of Ordnance: "This Arsenal has been doing everything possible during the past six months to get the Blank Company into production on 75mm guns. These measures have included everything from persuasion and threats to cooperation and assistance. We have sent some of our own breech rings to them, and have diverted others from the manufacturers direct to the Blank Plant." The Arsenal itself was fortunate in being able to start expansion and get into production on a heavy volume of business long before war was actually declared. The partial emergency proclaimed by the President on September 8, 1939, and the unlimited emergency announced on May 27, 1941, untied the hands of the government establishments and helped somewhat to prepare the nation for the impending war.

The Gage Division was a section of the Arsenal's Prodction Department which was especially rushed in the early months of expansion. At the end of World War I, all gages for army cannon had been stored at Watervliet. However, adoption of later model guns necessitated new gages which had to be furnished not only for the Arsenal gunshops but also for Ordnance Department Inspectors located in private manufacturing plants. Most big guns have from forty to seventy parts, and gages for each mating part were needed; with the mass production in progress, many sets of gages were necessary so that every gun of the same caliber made in the nation would have interchangeable parts. Whenever the design of a gun was changed, new gages had to be made to match, although all gages for old guns were retained so that repair parts for the used guns could be checked. Each gage carried its individual number and its historical record was on file at the Ar-

INSPECTORS — Gage inspectors pose following graduation from six-week training course in 1940.

senal. The gages themselves were checked with the latest precision measuring instruments—standards were set by "standard blocks" of which the Arsenal had approximately eight sets, and which in turn were measured by a master set of blocks and one grand master set. These were calibrated and were certified by the Bureau of Standards and were housed in a special fireproof vault located in the center of the building so that there were no outside exposed walls. Both temperature and humidity were carefully controlled and the instruments were calibrated at a temperature of sixty-eight degrees, the international standard. When the design of a gun was revised, new gage drawings were made, sent to the Inspection Gage Sub-Office for approval, and then were traced on linen for permanent record. The Gage Division also repaired, received, and issued all Ordnance inspection cannon gages used in the United States and was responsible for training inspectors in the use of gages. Six-week classes for groups

of men from private plants and Ordnance District Offices were in progress for years, the first course having been held in the summer of 1940, with similar instruction given to Ordnance Reserve Offices from 1935 to 1940.

As a result of careful designing, manufacturing to close tolerances, and adequate inspection with well-designed gages, our country was able to build cannon the parts of which were interchangeable regardless of the manufacturer. This accomplishment was never before attained by any country and so far as is known, never matched during this war.

The fall of 1940 was a busy time for the entire Arsenal. By December, the Liner Shop was almost ready to make 75 mm guns, and a new shrink pit had been started in the Seacoast Cannon Shop. Floodlights were placed around the Arsenal and barbed wire was added to the top of the stone wall surrounding the post. Hundreds of Arsenal employees were attending National Defense Training Courses conducted at the Rensselaer Polytechnic Institute in Troy and at the public schools in Troy and Watervliet.

When 1941 arrived, the personnel totaled more than 3,000. To avoid a housing problem, local men and women were hired whenever possible. Construction and repair work were in progress in every part of the Arsenal grounds. A Field Service warehouse was started that spring, costing $446,238, and having floor space of 93,000 square feet in its three stories. Two new wings were added to the Administration Building at a cost of $130,511, giving 19,575 square feet more office space. The Broadway Building, which had remained practically unchanged since the Civil War, was remodeled for about $300,000 and turned into a manufacturing shop for 37mm guns. Work was completed in July on a newly-designed and enlarged main entrance to the Arsenal; the bridges over the canal bed were removed, the land leveled and planted with

grass, and a row of elm trees was set out along the main road—Dalliba Avenue. The remodeling of the old barracks into offices for the Works Manager was finished the same year and, with the aid of the WPA men, all officers' quarters on the post were renovated.

Despite the handicap of construction and repair of the shops, of materials arriving slowly, and thousands of new employees who had to be trained for their jobs, the production rate climbed rapidly. At the close of the fiscal year in June 1941, a total of 7,699 major items had been produced, ranging from 1,113—37mm M5 guns to nine 16-inch guns. Work was concentrated on the 37mm and the 75mm guns which were used on tanks. At the same time, the Arsenal was the only manufacturer in the United States of Army cannon over the 155mm caliber, and a large percentage of all guns under that size. By July 1941, the shops were thirteen percent ahead of schedule on production of all guns. By using castings instead of forgings for 90mm Anti-aircraft guns and for the 75mm guns, quicker and cheaper delivery was made possible. The castings or forgings were made at the steel mills and were delivered as rough cylinders of metal with holes through the centers. Only guns under the 8-inch size are made from a single piece of metal; above that size, the tubes are built up by successive shrinking of jackets. The first step in making a gun is telltaling, which is much like laying out a paper pattern on cloth to cut out a garment. The rough forging or casting is next checked for straightness and if found out of line, it is corrected in huge hydraulic presses. Then begins the careful boring, reaming, honing, and rifling. Gages are used to assure the accuracy to within from 2/1000 to 4/1000 of an inch.

Metal of low tensile strength is coldworked while in a rough state to improve its quality. In March 1941, trouble was experienced in coldworking 155mm guns and 8-inch howitzers, and the tubes were shipped to

Watertown Arsenal for that processing, so that production would not be held up. However, by June of that year, coldworking at Watervliet was perfected. Tubes for 240mm howitzers, T1, were being successfully coldworked by fall. These were the largest to undergo the process up to that time. Production at this time was also successfully going forward on all types of cannon: there were 208—37mm guns, M3, produced in November 1941, and the rate for 75mm guns, M2, had reached 238 a month. At the end of November there were 4,714 employees and 24 officers at the Arsenal.

December 7, 1941, was a clear, cold Sunday and officially a day of rest and relaxation for all employees of the Watervliet Arsenal. The threat of war with Japan seemed remote because the two Japanese "peace" emissaries were in Washington to discuss "an improvement of relations" between the two nations. However, that afternoon all radio stations interrupted scheduled programs at frequent intervals to bring the stunning news that Japanese planes had bombed Pearl Harbor, Hawaii. All servicemen were ordered to report to their posts immediately in uniform. Officers and key employees of the Arsenal reported to the post. The production machinery was set to "full speed ahead."

The civilian guard force totaled fifty at the beginning of the war, but was immediately increased and continued to grow until there were 131 guards early in 1943. Air raid instructions were issued soon after the nation entered the war, appointing air raid wardens in all Arsenal buildings and assigning duties to each officer in connection with blackouts. For the following two years, fear of air raids kept practice blackouts in force at irregular intervals and, with the wailing of every siren in the community and the booms of bursting blackout signal bombs, every outdoor light was turned out and all traffic stopped. Lights inside buildings were concealed by heavy curtains, and the communi-

ties were checked by airplanes on their efficiency. The aim was total darkness broken only by the stars or moon—a difficult thing to attain. In the Arsenal, all lights were extinguished except those absolutely essential for the production of the vitally-needed guns and wall protection. Master switches were made ready so that all lights could have been turned out immediately if a "Red Signal," denoting approaching bombers, had been received. Fortunately, the actuality never necessitated their use, and the practice of holding frequent and regular blackouts was abandoned early in 1944. On 29 May 1945, the instruction concerning Air Raid signals and procedure was rescinded.

The work of the Arsenal was very well described in a radio speech made in April 1942, by Colonel Steven L. Conner, Engineering Officer: "The reports of the production of armament have emphasized the efforts and the accomplishments of industry in the production of airplanes and tanks. These weapons are the strictly modern contributions of civilization to the art of destruction and are primarily means of transportation for fighting men and fighting equipment. But little has been said about the production of cannon, and this absence of emphasis is, in fact, a high tribute to Watervliet Arsenal. The production of cannon in this country has been exclusively an activity of the Army and the Navy for many, many years. Thus, the Army's cannon factory, which is at Watervliet, and the Navy's gun factory are really a public service, somewhat analagous to such activities as the lighthouse service. And in between our wars, the design and manufacture of cannon in the United States are done at only these two places. So when war starts, all the knowledge and technique of this highly specialized manufacture is concentrated at them. Because of this, Watervliet's part in the armament program is a large and important one.

"Some two and a half years ago, when the re-armament of the United States was

started, all of the cannon business in the Army was concentrated at the Watervliet Arsenal. Acting under orders of the Chief of Ordnance, private industry was circularized and slowly but surely production was inaugurated under Arsenal guidance in privately-owned plants. Businessmen came to the Arsenal and obtained their contracts. Engineers and master mechanics from their plants came to the Arsenal and spent weeks in our shops and our drafting rooms learning about the material they were to produce. Their specifications and requriements for machinery, their tool design, and gage design, the specifications and requirements for their materials, the speeds, feeds and cuts they were to use, were all based upon the practice at the Arsenal.

"During the long tooling-up period of preparation, the Arsenal gave help and advice to an ever-growing list of manufacturers, and as production began, waited anxiously to see if all were well. It is good to be able to report that in every case, industry is producing cannon that the Arsenal is proud of.

"At present, the Arsenal's function in the ever-growing volume of cannon production is three-fold. First, there has been established at the Arsenal, with Arsenal personnel, a branch of the Cannon Section of the Office of the Chief of Ordnance. This branch is charged primarily with the allocation of orders for cannon and gun forgings to people who are producing, and with the uncovering through use of the Ordnance Procurement Districts, of such new facilities as may be necessary.

"Secondly, this Sub-Office acts as a clearing house for the necessary answers by Arsenal personnel to the innumerable questions which are constantly arising. These questions are concerned with production, engineering, and inspection of cannon of all calibers. Production men, engineers, resident Ordnance inspectors at private plants are constantly confronted with problems peculiar to making cannon. And it is to

this Arsenal that all of these questions are addressed, and from which the answers must come. In addition to this, the engineers and the master mechanics are still at the Arsenal learning the fundamentals from which will soon start an added flow of cannon from still more private plants.

"Finally, the Arsenal itself is a roaring hive of activity. While the men from industry were preparing to produce, the Arsenal itself began to grow. Working under pressure, whole buildings filled with specialized gun-making machinery which was left over from the war of 1918, were cleared. Hundreds of carloads of machines were sent out to initiate the equipment in the plants of private manufacturers. Hundreds of machines, both old and new, were installed in the Arsenal shops. Employment rose by leaps and bounds. The hard core of foremen and master mechanics in whom the art of building American cannon rests, worked day and night planning, training men, and building up their operating forces. The curve of production rose steadily until now a year's production of four years ago, is made in less than a day. New methods, new machines, and old machines are producing cannon of all sizes from the powerful little 37mm to the mighty 16-inch rifle at a rate many, many times that ever before seen in America. And while the private manufacturers are magnificently producing cannon in ever-increasing numbers, when the records are finally compiled, it will be found that the Arsenal at Watervliet has been the greatest producer of them all!"

Production of guns at Watervliet Arsenal reached an all-time peak in 1942. Most of the guns were the 37mm and 75mm to be installed on tanks, antitank vehicles, and in airplanes. Even with the hardships in getting materials to keep the machines full, and the troubles encountered when the draft began to take male employees, the number of cannon units produced continued to climb, with emphasis placed on different types of guns, as

the demands varied. In the one month of July 1942, the Arsenal produced 619-75mm guns, M3, for installation in the "General Grant" medium M3 tanks, which were used on the sands of Africa. The same month, 484 (37mm guns, M3, were produced for use on the light M3 tanks) orders for both of these tank guns were cut that month, as the requirements were reduced. December 1942, stands out as the top production month when the greatest number of guns ever turned out in one month totaled 3,458. The production highlights of that month are statistically interesting:

Gun Model	Quantity
90mm guns, M1	270
75mm guns, M3	219
75mm guns, M4	204
75mm howitzer, M1A1	345
75mm howitzer, M3	114
75mm howitzer, M2	72
37mm guns, M6	481
75mm gun tubes, M3	182
37mm gun tubes, M1A2	351
37mm gun tubes, M4	280
3" gun, M7	209
4.5" guns, M1	14
4.7" gun tubes, T2E1	9
6" guns, M1903A2	7
155mm gun tubes, M1A1	40
155mm howitzers, M1	9
8" howitzers, M1	11
8" guns, M1	3
240mm howitzers, M1	2

The six hundred and thirty-one tubes for 37mm guns, used on antitank vehicles, were shipped to the Colt Patent Firearms Company, where the mechanisms were made; other tubes were made for the repair of worn or damaged guns. The 75mm pack howitzer was especially helpful to the soldiers fighting in difficult terrain, as it could be disassembled into six parts while being transported.

Along with rapid production went research and experiments to improve manufacturing methods and the guns themselves. New methods of cleaning the guns shortened the time to about one-tenth of what had formerly been necessary, while spray painting the 37mm and 75mm guns and then baking them in ovens cut the time necessary to paint one gun from two days to four hours. Study of coldworking was given particular attention. The cannon

Sub-Office of the Office of the Chief of Ordnance, having been established in March, started operating efficiently. Contracts for guns with private manufacturers were made through the Sub-Office, and amounted to more than $200,000,000 during 1942.

The greatly increased production schedules necessitated the construction of many new buildings and additions to existing buildings. The extension to the Broadway Building for the Heat Treat Department was completed in March 1942. When the plans had been drawn for this wing and workmen had begun to excavate for the foundations, they discovered that some foundations of the exact outline of the blueprints were already in place. A search of the construction records of the Arsenal re-

TANK REPAIR — BG Gillespie, left, talks with MG Campbell in front of new tank repair building on Sept. 13, 1943.

vealed that in 1865 work had been started on an extension in the same location, but at the end of the Civil War the building was discontinued and the foundations had been covered and grown over with grass during the passing years. By summer a fine new manufacturing building, GW, was completed and put into operation making 4.5" guns. The floor space of the structure, which had cost $688,759, totaled 105,290 square feet. At about the same time an important addition to the Carpenter Shop, GK, was finished and a small melting plant, GX, was completed in August. The new Tank Repair Building, TR, was opened in August, giving 48,445 square feet of floor space for the repair and reconditioning of tanks at a cost of $326,620. A mezzanine which ran the full length of the west wall was used for the repair of tank engines, and a dynamometer building, TS, just south of the tank repair building was completed in September. Extensive additions were made during that same year to the Liner Shop, Breech Mechanism Building, Heavy Field Artillery (Shop 35), the Seacoast Cannon Shop, and the Chip and Degreasing Building.

A little more than twenty acres of land were added to the Arsenal grounds in April 1942. The land was in two plots, one to the south of the apex of the triangle formed by the Arsenal grounds, the other to the northwest of the apex, and was needed to provide facilities for manufacture of large caliber guns and for a large warehouse. The storage building, SH, was erected on the northwestern addition and furnished 113,775 square feet of space for warehouse uses. The original cost of SH was $212,000, and the next year an outdoor concrete storage area was added. As this warehouse was isolated from the other buildings and was unheated throughout the year, it won the appropriate name of "Siberia" from the employees, which aptly described the bleak surroundings and bitter cold during the long winter months. The building erected on the south-

SIBERIA — New warehouse, isolated and unheated, soon earned the nickname "Siberia." It is still in use today.

ern plot of ground was called "GQ". Started in July 1942, it was not completed until one year later, although machines were installed in May. The new structure, which cost $2,519,419, was reputed to be the finest cannon factory in the world, having a floor space of 186,645 feet and incorporating corrugated glass walls, with actinic glass used on the south and west to cut glare, bound by the brick corners, which gave the building a look of futuristic streamlining, making the inside brighter for the workers with a uniquely uniform light. There was an uncluttered, clean, efficient, air about the whole structure. Shrink and furnace pits were installed and a 10,000,000 pound coldworking press was placed in the coldworking pit. Because of the superbly efficient working arrangement in Building GQ, the rate of production proved to be much faster than in older shops when work was started on the 155mm gun, 6-inch, 8-inch, and 16-inch guns and the 240mm howitzer.

Keeping Watervliet Arsenal supplied with trained workers was a serious problem during 1942. When the year opened, there were 5,312

BUILDING 135 — Constructed at a cost of $2,519,419 in 1942, it was called "the finest cannon factory in the world."

employees, and at the end of the year the number climbed to 9,332, while 1,041 had been furloughed to the armed services. Women helped in this situation—in February of that year women began to be hired for such positions as toolkeepers, gage checkers, and mechanic learners. By the time summer had arrived, they were being used as inspectors, crane operators, machine operators, and benchmen. In December 1942, there were 2,905 women on the Arsenal payrolls and 6,427 men. The number of officers stationed at the Arsenal had increased from twenty-six to forty, including officers from Ordnance, Engineers, Finance, and Medical Corps. Four enlisted men had been added to the eight who had been stationed at the post in January. Expansion was at its peak. The number of Mechanic Learners grew from sixteen to 1,832 during the year. A new class in the Inspector's School was started every six weeks, and the enrollment in the basic and advanced courses averaged about thirty men to a class.

A shortage of steel in the nation induced a scrap drive

in which the Arsenal joined whole-heartedly, and by September the post had disposed of over 20,000,000 pounds of ferrous and 124,000 pounds of non-ferrous scrap. Included in the carloads of scrap that were moved out of the Arsenal were some of the large cannon balls which had been piled at the base of the flagpole since Civil War days. Small cannon of no historical value and the iron fence which had bordered Broadway along the river front were also donated. Other shortages became apparent during the same period, and in June 1942, rationing of gasoline was initiated. The use of gasoline and oil on the post was curtailed, cars of employees entering the ground were checked to see that each car carried at least three riders, horses were put to use pulling wagons for the Grounds Crew, and guards rode saddle horses instead of using automobiles for some of the night tours.

As 1943 began, the Field Service Depot at the Arsenal had a very heavy work schedule. The receipts and issues of Ordnance materiel showed a steady increase month by month, and because of large quantities of trans-shipment materiel received and held for Ports of Embarkation, the amount of space available for additional storage at times became critical. The facilities were further taxed by the large volume of Lend-Lease orders which passed through the Arsenal supply depot, and it was found necessary to convert about 45,000 square feet of space in the Field Service warehouse to parts bins for the storing of artillery items from which small orders could be filled more quickly. The Maintenance Section had a fifty percent increase in personnel in the late spring to handle the increased number of combat vehicles received for overhaul.

Nearly one hundred carloads of new supplies had to be placed in open storage during August and September, a job which overpowered the five hundred employees in Field Service. A local shortage of manpower, moreover, caused an actue

problem in replacing regular losses of full-time workers. To meet the situation, the depot initiated a new procedure and employed part-time workers known as "Commandos." These individuals held regular jobs elsewhere, and came to the Arsenal to work from 6 P.M. to 10 P.M. for six nights a week and for the full day shift on Saturdays and Sundays. There were over two hundred Commandos working at the Arsenal by the close of 1943 and a peak of 233 was reached in January 1944, which fell off somewhate later in the year. The Commandos, students and outside workers, and women helped to meet manpower requirements duirng 1944. On June 1, 1944, there

WOMEN AT THE ARSENAL — World War II brought many women into the arsenal shops.

GRINDING — Mrs. Helen Sams grinds cutters of large gun reamer during 1943.

were 4,598 men and 2,659 women, while 2,131 employees had been furloughed to the armed forces. Skilled male laborers were at a premium. However, after being trained, hundreds of women became skilled enough to perform jobs in the shops, doing work which in the past was not believed possible for them to handle. Of the 4,295 trained as Mechanic Learners since 1942, 2,241 were women. Manufacturing methods had to be revised to eliminate as much heavy lifting as possible, and more constant supervision had to be provided so that the work would flow continuously. In the maching phases, the work was broken down into the simplest components and was assigned to the less skilled workers, while the final and more difficult operations were performed by the remaining skilled machinists. Women were found to be especially adept at gage checking, engine and vehicle repair, crane operation, tool grinding and welding. A drive for students to work on a temporary basis during summer vacations was begun in May 1944, and approximately 250 local high school students had signed up for such work by the end of the month. Plans were laid to recruit college girls and teachers in June. A shortage of auto mechanics for the tank overhaul program in the Field Service Depot was alleviated in April by a field force of about one hundred Traveling Automotive Technicians sent from the Office of the Chief of Ordnance, Detroit.

A new plan completely reorganized the personnel group of the Arsenal during the fiscal year 1944, consolidating under one head such functions as Personnel Relations, Wage Administration,

Employment and Training Programs as well as those pertaining to Safety and Suggestions. The Employees' Relation Group, which acted as a liaison between female employees and their various department heads, was developed to a high degree of efficiency with competent, experienced welfare workers at its head. A counseling service was hereby made available, which, without interfering with productive operations, received and investigated alleged grievances and in almost one hundred percent of the cases involved, eliminated the difficulty before it reached the formal grievance procedure stage. The Wage Classification Section which covered wage control for per diem workers, and the Classification Analyzation Section for per annum workers were expanded and achieved a fair degree of success. This type of control was new to the arsenals in 1944, as delegation of these functions had existed for only two years. Audits by the Office of the Secretary of War disclosed excellent conformance to existing laws and regulations, and revealed a small percentage of error, mainly in the application of job titles in per diem occupations. Payroll and Finance were also completely reorganized, and cash payments were abandoned in favor of payment by check, with a consequent elimination of lost time in lining up and receiving envelopes. The first check payments were made on 22 October 1943 and about $180,000 a year was expected to be saved by the new method. Addressograph equipment and payroll machines were installed which effected sizeable economy in operation, making it possible to furnish each employee with his pay check, a complete statement showing earnings, deductions, and net pay.

In October 1943, the absentee rate of the Arsenal was less than two-tenths of one percent and the quit rate was about two percent a month. The latter dropped to approximately one percent by May 1944, which was the lowest it had been for several years,

and was far lower than the average rate in war plants throughout the nation. The A.W.O.L. rate also continued to be very low. By keeping everyone conscious of daily attendance and by the check-up through daily reports by the Commanding General, who also required the supervisors to obtain written statements from employees who were A.W.O.L., the personnel in general were discouraged from staying home except when absolutely necessary. The Arsenal's absenteesim rate reflected this effort and was consistently less than half the normal rate in commercial industry. However, it took a decided jump in July 1944 when an ASF Circular was received from the Ordnance Office stopping all leaves. Coming as it did without warning in the midst of the vacation period, it caused, to say the least, considerable comment, some unrest and some resignations. Each individual's request for leave was reviewed by the Commanding Officer who, in a few exceptional cases of extreme necessity, granted shortened leaves to employees. A few days later the order was amended and the situation returned to normal. Exit interviews were developed to a high degree of efficiency and resulted in acquainting management not only with the reasons for separation but with cetain inequities such as the lack of uniformity in pay increases and other conditions which upset harmonious relations between employee and management. These interviews also offered an opportunity for convincing the employee that he was in error in his various assumptions and gave management a chance to eliminate misplacing employees by means of transferring them to other departments. From twenty to thirty-five percent of such employees were thus saved from separation, and approximately fifty percent of the grievances were satisfactorily adjusted.

The ceiling for employment at the Arsenal was set by the Chief of Ordnance at 7,807 for September 1943,

and later was cut to 7,571. No discharges were needed to bring the number of employees down to a required ceiling on the date specified, as the normal decretions due to resignations and separations for irregular attendance took care of it; the Arsenal always remained below the ceiling set, and the personnel was maintained on a basis of work to be done. Because of the continued shortage of labor, it was necessary to work about forty percent of the employees on Sunday during the fisal year 1944. This was equivalent to approximately five hundred men on a 48-hour week basis.

The morale of the Arsenal workers was consistently high during World War II, and there was no friction between labor and management, all of which could be traced to a consistent policy of administration headed by a particularly capable and well-liked Commanding Officer. General Gillespie's active interest in the employees, their welfare, their sports, and their work was a valuable asset. Local people were hired insofar as possible, and a constructive attitude was maintained regarding employee relations in general. In recognition of the faithful service of the Arsenal workers, a ceremony was held in December 1943, at which token awards were given to those who had completed at least six consecutive months of satisfactory service with the War Department. Employees with ten years' service were honored in April 1944, when they received special tokens and in April 1945, eight men received meritorious and exceptional civilian awards in recogntion of their outstanding contributions to the Ordnance Department. Messrs. Preston A. Horn, Charles T. Kohler and Frank A. Miller received the Exceptional Civilian Service Award; and Messrs. Leon W. Dwyer, Michael F. Kerin, John P. Kilmer, Fred H. Prins, and Wilmot H. Roblin, received the Meritorious Civilian Service Award.

The Apprentice Class which had begun in 1939 graduated thrity-four young men as journeyman machin-

ists in January 1943. It was the first Apprentice Class to graduate in ten years and the highly-trained workers were exceedingly welcome in the Arsenal gunshops. As an emergency measure caused by the manpower shortage, the training school for Apprentices and Mechanic Learners was reduced to a skeleton staff in January 1944, to provide personnel badly needed on production to meet imperative cannon schedules.

Work in the Arsenal gunshops was more dangerous than in many establishments, but intensive efforts were made to reduce the frequency and severity of injuries to employees. Persistent safety reminders to the shop management which were passed down by various means to all personnel, dropped the accident frequency rate from an average of 21 percent in 1942 to 7.0 percent for the year 1944. During 1945, the accident frequency rate was 8.70. There were no fatal accidents in 1943, in comparison with one fatality in 1942. Careful instructions in the use of protective goggles resulted in a record of no eyes lost in 1943, while four had been lost during the previous year. These figures included Field Service activities which, throughout the country, had a higher rate than the arsenals themselves, and were a commendable tribute to the Safety Officer and his staff. Arsenal safety contests were held to aid the accident prevention program by providing supervisors with another means to help them arouse employee interest in preventing accidents. These contests accomplished their purpose. The PR (Shop Maintenance Department) which and always had the poorest safety record of all the large departments, won the second contest which ended 31 March 1945. It had been the concensus that this department had greater safety hazards and would probably continue to suffer serious accidents, but the results of the contest proved that regardless of the hazards encountered, work can be done efficiently as well as safely.

The Watervliet Asenal

was awarded the Inter-departmental War Bond Savings Committee Certificate and the Minute Man Flag in December 1942, for attaining the Treasury Department goal of ninety percent of their pay. These awards were made in December 1942, and the Arsenal maintained requirements throughout all the ever-increasing War Loan Drives. Records state taht from 15 May 1942 until 31 August 1945, $5,682,230 had been invested in the war effort by the Arsenal workers, exclusive of cash purchases.

The handicap created by the drafting of men under twenty-six years of age in the spring of 1944 was somewhat relieved by the return to the Arsenal of about seventy of these men immediately after induction. By June, fifteen of the promised seventy had reported back to the shops for work, where their skills were made use of as formerly except for the fact that they now wore uniforms and received a soldier's pay. In April of 1945, there were fifty-one enlisted men in the shops, the majority as privates, although a few had received promotions to PFC. The difference between fifty-one and seventy was due to the fact that some men were rejected for physical reasons, and some were never called by their Draft Boards. In June of 1945, 49 of the 51 enlisted men stationed at the Arsenal, who had been assigned to duty in the Manufacturing Department, were relieved from duty and were assigned to Aberdeen Proving Ground, Maryland, because of the need for men in the army and lack of drastic need for the added manpower at Watervliet. Every attempt was made to integrate physically-handicapped workers into the Arsenal's work cycle. After a thorough physical examinatin by the Medical Officers, the applicant was placed in a type of job in which his physical handicap would not place any limitations on his efficiency. The employment of veterans was also emphasized, and on June 1, 1944, there were 866 veterans working on the post, 107 of whom had returned to duty after serving in the

Armed Forces in World War II and 759 of whom had been in previous wars.

Production in the Arsenal gunshops shifted emphasis from the smaller caliber cannon, which were assigned to private manufacturers, to higher caliber guns, during the fiscal year of 1944 because of the change in the type and methods of warfare. At the year's end, in addition to carrying out a heavy schedule for guns of many calibers, intensive preparations were underway for greatly-increased production of heavy mobile artillery as the need for the small caliber guns had decreased. Before the autumn of 1943, the Arsenal had produced approximately 10,000 each of 75mm and 37mm guns. Production of 155mm guns began in June 1943, for the first time in two years, the guns having been made by a private manufacturer in the meantime. The importance of this and other heavy artillery having been made evident by the fighting in Africa and Italy, preparations for the invasion of the Continent were underway. General Levin H. Campbell, Jr., Chief of Ordnance, credited the 155mm guns with "doing as much as any gun to drive the enemy out of Tunisia." The American troops called it the "Long Tom" and were impressed by the speed with which it could be towed by truck and, when in position, by the fact that it could be fired at the rate of one round per minute, sending its six-inch shells for a distance of more than fourteen miles.

The next largest gun made by the Arsenal was the 8-inch gun, which had a range of twenty miles and fired either high-explosive or armor-piercing shells. The largest American field piece was the 240mm howitzer, which had a range of fourteen miles and greater accuracy than any other big gun. With the exception of railway artillery, this howitzer was the largest piece of mobile artillery used by the American Army in World War II and was the most destructive mobile weapon of siege warfare ever devised. During the period from 1 July 1943 to 30 May 1944, the Master Schedule

called for production of a total of 9,888 cannon, 99.95% of which were completed on time. This was in keeping with the former outstanding production record of the establishment—from Pearl Harbor to June 1944, the Master Schedule had called for 23,211 cannon, of which 23,183 were produced on schedule making an overall average of 99.96%. In addition to the cannon, thousands of spare parts and other items were manufactured in the Arsenal shops. Twenty-eight different kinds of guns, howitzers, and mortars, ranging from the 37mm to 16-inch cannon, were made at Watervliet during World War II up to June 1944. The largest variety produced by any one private manufacturer was eight, ranging from the 20mm to the 76mm cannon. Besides the regular types of guns, the Arsenal also made thirty-four different experimental "T" models.

Firepower produced by Watervliet Arsenal and industrial concerns in the United States totaled 54,668,429 ft/tons for 1943, of which the Arsenal alone produced 17,108,229 ft/tons, or forty-five percent as much as all industrial concerns combined. Although the personnel of the Arsenal was reduced during the fiscal year 1944, the efficiency rose and the average firepower produced annually per employee was 905 ft/tons in 1941, 1,780 ft/tons in 1942, 2,060 ft/tons in 1943, 3,070 ft/tons in 1944, and 2,429 ft/tons from January through September of 1945, showing an increase in efficiency of 96.8% in 1942, of 15.7% in 1943, 49% in 1944, and 6% for the first nine months of 1945.

From 1 July 1943 to 31 August 1945, funds totaling $23,966,905 were allotted by the Ordnance Office to cover the manufacture of Ordnance material. This sum represented monies allotted under the individual procurement authority system of funding. Of this amount, due to savings from manufacturing efficiency and economy, $8,837,668 was returned to the Ordnance Office. The savings indicated the downward trend in cost of manu-

facture and were not due to inflated estimates. During the period 1 January 1941 to 31 August 1945, funds allotted under this system of funding amounted to $156,769,280 and revocations therefrom totaled $46,951,953. The blanket procurement system of funding was inaugurated in March 1944. Under this system revocations were no longer made on completion of individual production orders assinged, but the total allotment was retained pending completion of all the work directed thereunder. Since the inception of the system, 1 March to 31 August 1945, a total of $119,360,932 was allotted to the Arsenal. Of this sum, funds amounting to $28,031, 692 were returned to the Ordnance Office upon completion of all work directed.

The millions of dollars worth of materiel produced in the Arsenal shops was not manufactured without difficulties. Rush jobs were common — an example of which was the order in November 1943 for 500 — 105mm mortars which were needed by 31 January 1944. The barrel of this mortar consisted of two sections which screwed together, each light enough for one man to carry. Before beginning actual production, it was necessary for the Arsenal to make three different types to determine which was the most suitable. To overcome the inability to get material in time to meet the deadline, rejected 76mm tubes were salvaged, cut into three sections, re-heat treated, and machined into 105mm mortars. The new Arsenal Melt Shop made the castings for the base caps and by exerting every effort possible, 483 of the 500 requested were shipped by the thirty-first of January, and the balance, in February. In April 1944, when the demand for larger cannon was increasing daily, a 155mm rifling machine broke down causing a serious bottleneck. The repair men began working on it immediately and continued unceasingly for over two days to get the vital machine back into working condition. The list of production difficulties

is never-ending, but the output of production followed the same voluminous lines, and schedules were steadily met.

Changes in schedules and losses in manpower made it necessary during the fiscal year 1944 to institute better control methods in order to insure that the cannon schedules would continue to be met. The systems varied widely, depending on the kind of gun involved. On large cannon such as the 8" gun or the 240mm howitzer, individual gun control was used. On guns of greater production and smaller size, operational gun control seemed to bring results. Monthly schedule charts of major components were given to each department, breaking the production into daily requriements, and weekly reports were submitted by the General Foremen, showing weekly and cumulative production for the month with explanations as to why items were behind schedule. The status of all major components of the large cannon were checked each shift by Production Follow-Up men and daily reports of the findings were given to the Production Control Officers. Operational schedule boards were established after the operational times had been charted,which showed on what machine a particular tube was and where it would go for the next operation. Production began to level out during the month, and the systems also aided in forecasting possible bottlenecks thereby making it possible to correct them before they could adversely affect production. Efforts were continually bent toward obtaining finer control in order to further ease production problems, create a smoothly-running organization, obtain better efficiency and, of course, the required number of cannon per month.

Constant efforts were made not only to reduce production operations, but also clerical operations. O 16 September 1944, a new Timekeeping System was inaugurated which resulted in an annual saving of approximately $50,000 and a

net personnel reduction of thirty-four employees. Briefly, the new system delegated the responsibility for maintaining leave records, etc., to each department rather than the Leave Section of the Payroll Department, thereby abolishing a duplication of records.

Because of the greatly increased demand for large caliber cannon in April 1944, particular efforts were made to improve the production methods on guns ranging from the 155mm howitzer to the 8" gun and 240mm howitzer. The high-speed production methods which had proved most successful in the mass production of smaller caliber cannon were modified and applied to the manufacture of the larger guns. Tungsten carbide-tipped cutting tools replaced steel cutting tools on the turning operations of exterior turning on the gun tubes. One very important improvement was button-type broaches for rifling in place of the older, slower, rifling heads. Grinding of recoil surfaces replaced the slow finish turning and draw filing previously used. The step threads on the 155mm guns and 8" howitzers were machiend on a special oscillating hydraulic machine instead of the conventional jump turning lathes. These, and many more improvements, reduced the time and machines required for the operations on large cannon by more than fifty percent. Considerable advancement was also made during the fiscal year 1944 in the methods used to manufacture breech mechanism components. The use of automatic profile milling machines, turning lathes, and more extensive use of carbide-tipped milling cutters reduced the time necessary for the manufacture of the smaller components also. Special attention was given to improving the manufacturing methods of products for which the Arsenal was the main supplier. Methods used for making split rings and gas check pads were greatly improved by the application of modern production processes and shop layout. Bench and assembly

work were made more efficient by the use of conveyor lines and a more extensive use of power tools.

Early in July 1944, the Ordnance Office requested the Arsenal to increase its production of 90mm guns to meet the urgent demands of the troops in Normandy and, as usual, the Arsenal had an affirmative answer.

Experimental work at the Arsenal kept pace with the needs of warfare also. Extensive improvements were made in 20mm guns and further investigations were conducted on the 37mm gun. Studies were made of the 155mm howitzer breech mechanism which, with a spiral thread outline, it was hoped would prove satisfactory as it would save as much as fifty percent of the time required for machining the usual step-thread block. Experimentation was conducted on tube forgings made of carbon steel, blackening bronze surfaces of 90mm gun rails, on improvements of gas check pads, and repairing of worn-out gun tubes. The optical telltale, used in determining tube straightness and runout at initial set-up was developed at the Arsenal and proved entirely satisfactory and superior to previous methods used, reducing the required time for telltaling by fifty to sixty percent. Metallurgical examinations were conducted of materiel which had failed in proof firing or in actual combat, and reports were submitted to the Office of the Chief of Ordnance. The Experimental Division studied the manufacture of small precision castings made in the Arsenal's own foundry. By June 1944, production of the castings in plain carbon and low alloy steels amounted to several hundred a week and resulted in a large savings in cost over that of machining from forgings and bars.

Unusual vigilance was required of the Inspection Department because of the heavy production schedule in the fiscal year 1944, and the loss of inspection personnel to the Armed Forces. It was necessary for the remaining veteran key employees to carry extra burdens, espe-

cially in training replacements, and in addition to gage checking thousands of cannon, the Inspection Department assisted in the development of the precision casting project to the point which made possible the mass production of certain cannon parts with an accuracy which eliminated all machining.

The Field Service Depot at the Arsenal had a continuous expansion in the fiscal year 1944, in personnel, facilities, production, and volume of ordnance materiel handled. Officers increased from four to seven during the year, while the civilian workers increased sixty percent. The Maintenance Branch which was centered in the Tank Repair Shop, had the largest growth of any branch of the depot, with a personnel increase of 106 percent. With the warehouses loaded to capacity most of the time, many improvements were initiated to speed up the handling of materiel. Floor plans were revised and roller conveyor lines were installed. The Maintenance Branch overhauled and reclaimed hundreds of combat vehicles, engines, power trains, stabilizers and many other vehicle components. The capacity of the tank engine line increased from three and a half a day to seven a day when parts were immediately available. Vehicle overhaul and obsoletion increased from 35 to 90 a month.

In eleven months from 1 July 1943 to 1 June 1944, 361 contracts totaling $11,003,865 were terminated. The total amount of cancelled items was $4,185,025. Three hundred and fifty-one of the contracts were terminated without cost to the Government and the termination costs on the remaining ten contracts were $75,447.

The Facilities Planning Section of the Cannon Sub-Office, Office of the Chief of Ordnance, was established 5 November 1943 to prevent the complete dissipation of manufacturing facilities as a result of termination or severe curtailment of production programs. As contracts were completed, cancelled, or curtailed, the Facilities

Planning Unit surveyed the manufacturing facilities and made plans to provide for the retention of special or standard machine tools and aids to manufacture in accordnace with objectives established by the Central Planning Committee of the Artillery Branch. Reports were made to the Artillery Branch Chief of the items recommended for retention and the suggested place of storage. Lists also were submitted of standard machine tools which would be needed to implement a pilot line at a specified rate using those tools.

Disbursements at Watervliet Arsenal totaled $107,416,545.63 for the period 1 July 1943 to 31 August 1945. Of this amount, payroll disbursements totaled $42,913,430.37. From Pearl Harbor, 7 December 1941, to 31 August 1945, total disbursements amounted to $260,357,591.77. Wages and salaries claimed $72,217,444.52 of the total, while materials, equipments

"E" AWARD — The arsenal receives the Army-Navy "E" Award for performance in the war effort.

and supplies accounted for $121,783,307.91. The balance of $66,356,839.34 was attributed to sub-allotments made to other Ordnance establishments for equipment purchases, and miscellaneous charges for freight, travel, awards, and other contractual services.

Social activities at the Arsenal were kept at a minimum during World War II. A military band and a choral society were formed and performed for the entertainment of the employees at various times. The largest ceremony held up to 1944 occurred on 30 September 1942, when the Army and Navy Production Award was presented to the Arsenal. The red and blue burgee, given for excellence in the production of war materials, was flown below the national flag thereafter. By March 1945, the Arsenal had earned its fifth "E" award (fourth star).

Further recreational activities, all conducted under the supervision of the Waterlviet Arsenal Employees' Association which derived funds from food concessions on the post, were the athletic teams. In the winter, bowling and basketball were played and in the summer, the softball league with ten teams was very popular. The first football team since 1919 was fielded in the fall of 1944 and was composed entirely of Arsenal personnel-military and civilian. The inexperienced Arsenal team did not succeed in winning any games but this is understandable as they were pitted against such college teams as Rensselaer Polytechnic Institute, Cornell Junior Varsity and Colgate. In the spring of 1945, a six-team women's softball league was formed.

A contribution to the high morale of the workers was made by a public address system, installed in the shops in the spring of 1943. Musical recordings, sport and spot news, and safety instructions were broadcast to the workers during the lunch and smoking periods and at the change of shifts. The recreational activities were maintained at the Arsenal solely for the exercise and relaxation of the employees and

were never allowed to interfere with the prime purpose of the Arsenal-building guns.

As early as September 1944, the Arsenal plans for V-E Day had been made, based on the curtailed program received from the Ordnance Office, and hopes were high that the war in Europe would be over in October. It is interesting to note that although subcontractors were trying to manufacture heavy artillery, the Arsenal continued to be the only producer through the fall of 1944 and the mainstay for supply to our troops.

During the entire war period, traveling conditions were extremely bad, with busses and trains loaded to capacity. To alleviate this condition, civilian travel was restricted during holiday periods and government establishments were requested to deny annual leave where travel by public carrier would be involved for the period 15 December through 8 January; to avoid calling meetings involving travel; and to refuse all requests for government speakers at conventions and similar group meetings. Employees' leave requests for summer vacations were granted from the middle of the week to avoid weekend rush periods when military personnel stationed in this country had the opportunity, on occasion, to visit their homes.

On 13 March 1945, Brigadier General Gillespie was ordered to Washington on special duty and in his absence, Colonel Steven L. Conner, Engineering Officer, was placed in temporary command. General Gillespie did not again return to command the Arsenal but was appointed Chief of the Industrial Service of the Ordnance Department, Washington, D.C., returning on 6 April 1945 for a brief visit. The admiration and respect which the citizens of Troy and Watervliet held for the General were expressed by their honoring him with a testimonial dinner in teh Hendrick Hudson Hotel, Troy. Mr. Marvin, editor of the Troy Record, described him as a "combination human being and whirlwind who never lim-

ited himself to the quotes given him but went well beyond them." Members of the Arsenal Twenty-Year Club also gathered together at a party to bid him farewell and many were the tributes which the newspaper editorials carried.

Colonel Clarence E. Partridge assumed command of the Arsenal on 1 April 1945. Like so many of his predecessors, this was Colonel Partridge's second tour of duty. He was previously stationed here as Engineering Officer from 1933 to 1935. Colonel Partridge was a graduate of the United States Military Academy at West Point, the ordnance School of Technology and the Command and General Staff School at Ft. Leavenworth, Kansas. During World War I, he served with Ordnance Headquarters, Second Army, in France and after the war he was stationed in Germany for a short time. Prior to his transfer to the Arsenal, he was Chief of the Special Planning Branch, Executive Division of the Ordnance Department.

V-E Day, which had been anticiapted since October 1944, at long last occurred 8 May 1945 and in accordance with President Truman's request, workers at the Arsenal remained on the job so that there would be no break in the chain of supplies for our forces still fighting in the East. As a result of V-E Day, production schedules were adjusted causing a corresponding downwar trend in employment. "Reduction in Force" proceedings were instituted which took into consideration the employee's veteran preference, efficiency rating, and length of service. From 1 April 1945 through 30 June 1945, there was a decrease in employment of 680 men, 881 women and 51 commandos. Reduction-in-force proceedings did not account for the entire decrease in personnel as some either resigned voluntarily or were separated for various causes. By 31 July, a total of approximately eight hundred had been separated under Reduction-in-force and three hundred more either resigned or were separated.

Along with the reduction of personnel was a reduction in hours of work. On 27 June 1946, the Manufacturing and Inspection Divisions went on a forty-hour week (eight-hour day, five-day week) and shortly thereafter, the Gage Section and per diem employees of Manufacturing Stores Section followed suit thereby permitting the retention of twenty percent more employees engaged in cannon production than would have been possible had the work continued on a six-day week basis. The balance of the departments were on a forty-four hour week until 1 August when the tour of duty for all employees was forty hours.

The announcement of the end of the war with Japan came on 14 August 1945 and that same day all production work at the Arsenal came to a temporary halt. One of the periods of greatest challenge and greatest success for Watervliet Arsenal had come to a close. The hard-won peace was most welcome; but the further adjustments it would require would present the installation with problems for many months to come.

Chapter 10
World War II to the Korean War

Reduction-in-force proceedings were begun throughout the Arsenal immediately upon the war's end. Indeed, all employees in the Production and Inspection Departments and others involved in activities directly related to production had been told in advance (August 13) that when the end of the war was announced, they were to remain home until notified to return to work.

On September 4, those who were to remain on the rolls returned to the Arsenal. The reduction had been sweeping. On the last day of September, the employment figures showed a total of but 1,756. The decrease from April 1 was 6,107 persons.

The badge system of identification was terminated as of September 17, 1945, and all badges were turned in to department foremen. On September 20, the Cannon Sub-Office, Artillery Branch Office, Chief of Ordnance, was deactivated and in November, the Arsenal Print Shop ceased operations. Thereafter, all printing was requisitioned from designated Government Print Shops as purchases from commercial sources were prohibited.

The Apprentice Training Section started functioning

ARSENAL MODEL — Apprentices put finishing touches on arsenal model.

again in January and 29 men — all returned veterans of World War II — were being trained. Some jobs were taken from the Tool Room and were placed in this section and some of the men were loaned to various departments to advance their training. Sessions in related subjects were revised and correlated with the shop work.

On April 30, 1946, Colonel Partridge started on terminal leave, at the expiration of which he retired. His successor was Colonel John C. Raaen who was transferred to the Arsenal from Washington, D.C. Colonel Raaen was a graduate of the United States Military Academy at West Point, New York, a graduate of the Infantry School in Ft. Benning, Georgia, the Ordnance School, Aberdeen, Maryland, and the Command and General Staff School at Ft. Leavenworth, Kansas. He had the degree of Bachelor of Science in Mechanical Engineering from Massachusetts Institute of Technology. Colonel Raaen was awarded the Legion of Merit and the Distinguished

Service Medal for his services during World War II.

In January of 1946, the Ordnance Office approved the request of the Veteran's Administration for office space in the Arsenal and plans were made to house them in Building No. 40 (Broadway). All War Department property was removed and the building was renovated under the supervision of the Division Engineer. Pending completion of the repairs, temporary space was made available to them on the first and third floors of the Administration Building. The Broadway Building was ready for occupancy in May. There were many details to be arranged with the "tenants" such as the payment for heat, electricity, gas, water, removal of waste and trash, guard protection, etc., but all were accomplished satisfactorily.

A complete inventory was started in June of all tools, fixtures, gages, patterns and drop-forged dies on hand at the Arsenal. Gage drawings were brought up-to-date and those drawings not on linen were traced so that a permanent record of all standby cannon would be on hand. Required gages were stored, the surplus withdrawn and of this surplus, all standard gages were retained for future use.

Work was completed on the pairing up of approximately 8,800 War Reserve Forgings of various calibers with their corresponding test reports and they were then restamped for outside storage purposes. This was an important work because should the steel manufacturer's numerical identification or stamping become obliterated, the components would become valueless as the physical and chemical characteristics (pedigrees) are then unknown.

Reductions in personnel continued. From September 1945 to June 30, 1946, the total personnel was reduced from 1,756 to 1,326. The only new appointees were the veterans of World War II who were placed in an A-1-plus category. Approximately 800, or 60%, of the total force

were veterans. The balance was mainly male and female "career" employees (those employees having permanent appointments but with no veteran's preference). There were only 185 War Service Appointees on the rolls at this time. The number of female employees was 130, or 10% of the entire force.

All of the Arsenal's production work was combined in a single building — Building No. 20. This building was set up to produce in limited quantities any type gun ranging in caliber from 20 mm. to 155 mm. Progress was made in getting the idle Arsenal buildings and machines in standby condition. Thus, by midsummer 1946, the familiar wheel of Watervliet Arsenal's history had almost turned another full circle. The war was over. Its battles had been fought and won with the best weapons skilled and dedicated men could make. Most of the great machines which had shaped rough metal into precision weapons of defense were still and packed away. The Arsenal, itself a

FOREMEN MEET — Arsenal foremen share a laugh at a meeting. Col. Raaen is at front, center.

great machine, turned over very slowly in comparison to its throbbing activity in the preceding war years.

Employment was in decline, production was low and the outlook not bright. The "RIF" or "Reduction-in-force" that had begun following V-J Day continued apace as the year waned and a large cut in personnel directed by the Office, Chief of Ordnance at the end of September was to bring the Arsenal's human resources-its greatest asset-to a low of about 940 persons by June of 1947.

The Chief of Ordnance, Major General Everett S. Hughes, summed up the situation adroitly in a letter that fall to an area congressman who had protested the cutbacks at Watervliet: "An economy minded nation, "General Hughes wrote, "is not looking with favor on the expenditure of money for the purpose of sustaining an intelligent, well-trained crew of men ready to swing into the next war overnight." General Hughes was right but the "next war" was far from everyone's mind in those post-war months. The nation's enemies were but newly conquered.

One of the first difficulties the Arsenal faced as a result of the RIF was the problem of the returning veterans. While by mid-1947 employment had dropped about 400 people below the level of the year before, the proportion of veterans, who had preferred employment rights, had risen slightly to 61%. Some Arsenal officials began to fear that if the situation continued to intensify, the returning veterans would begin to displace employees with 10 to 20 years of gun-making experience.

All of the veterans, however, had previously been employed at the Arsenal. Some, it was true, worked at the Arsenal only a short time. Others, on the other hand, had had considerable experience at the Arsenal and only served a few months on active military duty. Also, some of the veterans had gained valuable experience in the military service. Thus, while the return of the veterans cre-

ated some special problems, the fear it engendered proved unfounded and the effect, if anything, was ultimately beneficial.

In communications with area congressman-who were concerned because the Arsenal had for so long been a keystone in the life of the surrounding communities-General Hughes stressed that he had no control over the cutbacks and assured them that the Arsenal would have an important place in the future of the War Department. And so it would; but for the present Colonel Raaen set the tone for the life of the Arsenal in the coming months by stating that "such a reduction in staff...[will make it]...necessary to eliminate functions heretofore considered essential and to combine activities. Such a situation is not ideal but is mandatory under present legislation. It will be necessary for the employees of Watervliet Arsenal to accelerate their work and thus compensate for any shortages." And so, for the time, the Arsenal tightened its belt another notch and went ahead with its business.

"Probably the most difficult of our remaining tasks is that of storing and maintaining the huge quantities of ordnance material now on hand at our installations together with the issuing of supplies and equipment to our peace time Army," wrote General Hughes in early 1947. A difficult task it proved to be and one which figured importantly in the life of Watervliet Arsenal in the post-World War II years.

Heavy storage, maintenance and supply duties following conflicts were an old story at the Arsenal but the familiarity of the task did not prevent a note of resignation from appearing in a report at the time which stated that the Arsenal had "again begun the massive job of cleaning up the backlog of returned materiel."

"Massive" was the work for it. From the far-flung battlefields and deports of the world, thousands of guns of all varieties, implements, forgings, and other equipment ad infinitum, flowed in

a continuous stream into the Arsenal.

One arsenal observer remarked that "by far the greatest volume of materiel returned to Watervliet consisted of special tooling and machines from commercial contractors located all over the country. In the mad rush to convert their plants from items of war to articles of peace, they stripped their plants and sent everything to us without taking the time or effort to properly preserve and pack it." All of it underwent continuous review in the light of changing Army requirements. In general, materiel to be retained was identified, repaired, painted, and issued or stored. Materiel to be disposed of generally went to scrap or salvage. An office of the War Assets Administration operated on the post for a time and received much of this materiel, until it was found that Arsenal personnel could handle it more efficiently.

The storage of weapons, machines, tools, and forgings, much of it for War Reserve, presented problems of maintenance and space. There was considerable effort devoted to finding the best methods of combatting deterioration in stored equipment and special containers and processes were developed for this purpose.

Despite continual disposal of large amounts of the equipment that came into the Arsenal, storage space was at a premium. Reports on the problem at this time are reminiscent of those following the Civil War and other post-war periods. The June, 1948, report noted that "if absolutely necessary" empty offices and warehouse aisles could be used for storage.

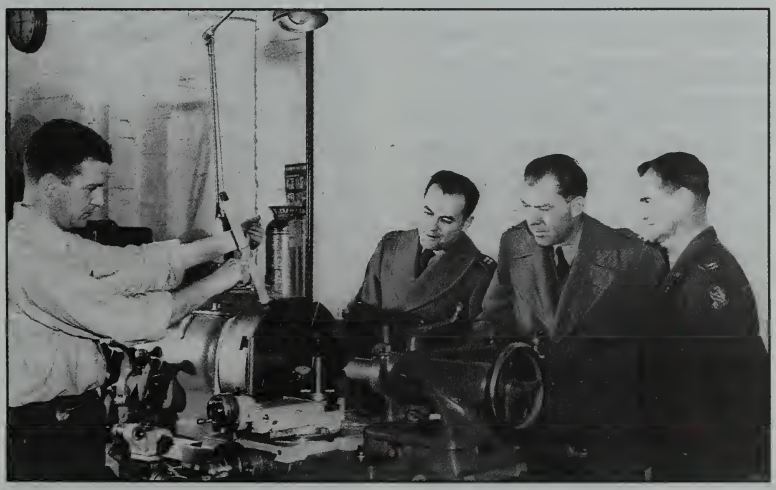
Besides scrap or salvage, a large quantity of the materiel disposed of went to educational institutions. Included in this were thousands of precision gauges and some armament. But more important were the many thousands of items of tooling, machines and weapons that were given to our allies.

These donations of weapons and industrial equipment became increasingly important through June of 1950.

At first, most shipments were sent to Greece and Turkey and while these allies continued to receive aid, by June of 1950 a Military Defense Program Account was established to aid the nation's friends and many weapons at Watervliet or its depots were earmarked for it. In that same month it was noted that there had been 121 shipments of materiel from Watervliet to Italy, France, Greece, China, Belgium, and the Netherlands since January 1950.

In 1949 and 1950 the emphasis on scrap and salvage lessened and the accent shifted to rehabilitation and preparation for a long term storage. Thus treated were several thousand guns from 8-inch howitzers to .30 caliber machine guns, approximately 450 machine tools and thousands of miscellaneous items.

The manufacture of weapons at the Arsenal began a slow but steady curve upwards from mid-1947 as the Arsenal in general began to undergo a reawakening. Field Service, storage and other general activities indeed accounted for a good deal of Arsenal life, but the



OPEN HOUSE — Arsenal training techniques are shared with the public during an open house in 1950.

true index of the vitality of the installation was the tempo of the manufacturing shops. As these began to revive, expenditures rose, employment rose, and a new air was evident.

Until June 1947, virtually all the manufacturing activity consisted in producing a few hundred 20 mm., M3 and M23 guns and several thousand 20 mm. trunnion blocks. A wide variety of experimental weapons had been made, but in very small quantities. In 1947 and 1948 however, several hundred 57 mm., M18 and 75 mm., M20 Recoilless Rifles were produced. Through 1949 to mid-1950 the burden of Arsenal manufacturing activity lay in modernization by conversion of 20 mm., and 90 mm. guns, new manufacture of a small number of 90 mm.'s and 81 mm. mortars. However, this work was sometimes quite pressing, as in January, 1949, when at a conference of representatives of Rock Island Arsenal, Watertown Arsenal, and Watervliet on work schedules, Rock Island agreed to relieve Watervliet of some of its spare part work in order to free men and facilities for the more important commitments.

In all, about 5,400 of the 20 mm. gun conversions were made and about 1,000 of the 90 mm.'s. The alterations to the 20 mm.'s which proved the mainstay of the Arsenal manufacturing during the period, were various. The changes to the 90 mm., a tank weapon, consisted chiefly in machining the muzzle exterior for two new devices, the muzzle brake and bore evacuator. The muzzle brake, which had seen some use by both sides during the war, but was still experimental, acted on the energy of the gases expelled from the bore by firing to lessen the gun's recoil. The bore evacuator, as its name implies, was a device for removing the gases of firing from the bore of a gun at the muzzle end. The device was intended for tank guns in an attempt to counter the World War II situation wherein the crew of a tank was liable to suffer acutely from gunpowder fumes seeping into the closed body of

the tank after firing.

About 500 improved 81 mm. mortars with mounts and baseplates were also manufactured in addition to the usual variety of experimental weapons produced in small quantities.

The much increased activity in procurement of weapons by Watervliet Arsenal, beginning in 1948, was another hallmark of the reviving life of the installation. National procurement of weapons and equipment by the Arsenal, so important a field of responsibility during World War II and an area soon to take on new significance, had dwindled to almost nothing following the end of the war. At that time, the organization of tube forging and finish machining facilities that had been set up throughout the country during the war was almost completely dismantled by government agencies outside the Ordnance Corps. This apparatus, composed of costly machine tools and buildings specifically built for artillery production and which had efficiently made thousands of artillery items, was sold for a very small part of the initial cost.

In 1948, however, contracts totalling somewhat over $4,500,000 were placed with private firms for manufacture of the 20 mm., M24, an automatic turret gun for the B36 Bomber; the 57 mm. recoilless rifle; the 90 mm., M3, a medium tank gun, and the 120 mm., M1, a heavy antiaircraft weapon. While this was not great in comparison with the tremendous activity of the war years, it was more than four times the procurement activity for 1947 and was a significant sign that the Arsenal was once more on the road to growth.

Employment at the Arsenal reflected the growing revival. From the low point of 940 people in June, 1947, the force had increased steadily to 1,075 in December, 1947, to 1,168 by June 1948; to 1,357 by December, 1948; and 1,484 by June, 1949. There were certain growing pains incumbent on such expansion, however. While some of the men lost in previous RIF's were rehired,

skilled machinists and toolmakers, capable of the exacting labor of gunmaking, were in short supply.

Many skilled former Arsenal workers, who had been separated in the RIF of 1946, had found positions with local private industry and were reluctant to return to the Arsenal so soon after being laid off. Unfortunately, this experience had dampened their confidence in the future of the installation and many did not rejoin the Arsenal force until 10 years later. It was necessary to have the manufacturing department work a six-day week for the first six months of 1948 because of the increased activity and shortage of manpower. Things in general were going well, however, and the Arsenal received an "excellent" rating after a general inspection during the summer of 1949. One thing in particular that went well in 1949 was the Arsenal participation in the First Army bowling tournament at Camp Kilmer, New Jersey. The Arsenal bowlers, resplendent in canary yellow shirts with red lettering, provided by the Civilian Welfare Council, placed third of 47 teams in the major event and ranked fourth for the whole tournament. The competitions drew wide interest throughout the Arsenal and the results were obtained by teletype from New Jersey each day. Yet the bowling team was only a part of the varied recreational activity in the postwar years. Arsenal softball, golf and basketball teams were prominent contenders in area athletic events and were often quite successful. Also, the recreation room on the third floor of Building 10, opened in October, 1947, received frequent use for Halloween and Christmas parties, club meetings and a variety of other activities.

Picnics and clamsteams were held by Arsenal organizations occasionally and one of these, an Arsenal 20-Year Club outing in September, 1947, took on an unusual significance as the occasion for the first meeting between the new Arsenal Commanding Officer and an important group of the employees.

In a memorandum Sep-

tember 2, 1947, Colonel Raaen had announced his relief from duty as Commanding Officer of the Arsenal. Colonel Raaen stressed his gratitude for the loyalty the Arsenal employees had shown him and wrote, "Serving with you for the last sixteen months has been an inspiration. Like your predecessors over the past 134 years you have been unstinting in your devotion to duty. You have made the commandant's job a pleasant task. For this I thank you from the bottom of my heart.

"Your new commandant, Colonel Rising, I can tell you from personal knowledge and without fear of contradiction, is a thoroughly capable Ordnance Officer who has served his country with distinction. With him at the helm the Watervliet Arsenal's star will shine lustrously..." Colonel Raaen went into retirement soon after leaving the Arsenal with an outstanding record of 30 years' service to the nation behind him.

Colonel Harry N. Rising came to Watervliet Arsenal from Aberdeen Proving Ground where he had been president of the Ordnance Board since the war. He had held sever important posts previously, including Chief of Ordnance of the Burma-India Theater during World War II, as well as important positions in the Office, Chief of Ordnance. Before serving in OCO, Colonel Rising had been an instructor at West Point for several years.

While the upturn in Arsenal activity in the procurement field was most welcome, the placing of the rather large contracts early in 1948 quickly brought a somewhat unpleasant fact into sharp focus. The "economies" practiced immediately following the war were now seen to have been "penny wise and pound foolish" indeed; for the new weapons contracts had to be placed with manufacturers with little or no experience in making guns. Thus, the tremendous work of reconstructing the nation's weapons manufacturing apparatus had to be begun again from scratch.

Procurement spending continued to rise through

1949 and by the end of the year contracts totalling $3,300,000 had been placed. Most of this was for the manufacture of about 2,300 recoilless rifles (mostly 57 mm. with a small number of 75 mm.'s). There were, however, other aspects involved, such as studies of Dickson Gun Plant as a source of tube forgings in the event of an emergency. The Dickson Gun Plant in Houston, Texas, had been a sub-installation of Watervliet Arsenal since May, 1947. It was turned over to the Field Director of Ammunition Plants while in standby in 1949, although Watervliet retained the responsibility of its utilization in the event of mobilization. Another important aspect of the procurement activity was supplying contractors with the special machines and knowledge to produce the items they had contracted for. Many conferences were also held with contractors on mobilization planning.

"In the next 10 years the Ordnance Department plans to complete research and development programs utilizing new principles and designs and to take full advantage of every resource of science whether military or civilian...", wrote General Hughes to the Arsenal Commander in the spring of 1947. The statement was most significant with regard to Watervliet Arsenal's future and coincided with the important announcement by Colonel Raaen that "the Arsenal has been given the responsibility of furthering the research and development program in connection with the design and manufacture of artillery."

To be sure, the Arsenal had had a part in Ordnance research and development from the beginning of its new weapons improvement programs in 1946, but, starting in 1947, it began to receive an increasing number of important assignments in this field and these reached significant stages of maturity in the growing revival of 1948 and after, and were, in part, responsible for it.

Included in the list of items Arsenal scientists and engineers either undertook

wholly themselves or through supervised contract were a wide variety of tank guns, mortars, recoilless rifles, aircraft guns, antiaircraft guns and field artillery guns, both towed and self-propelled. The qualities that Ordnance desired in the new weapons were generally that they should be lighter, more mobile, have greater fire power and lethality, be more durable with increased range, accuracy, ease of operation and repair and be capable of using a limited number of different types of ammunition. In short, the weapons were to be better in virtually every way.

Much of the early effort was centered on the 20 mm., M24, automatic cannon for aircraft and antiaircraft use and production of these items, as mentioned above, was an important part of the Arsenal's manufacturing and procurement effort. Also, development of a better 90 mm. gun than the World War II M3 for the medium tank was quite successful and resulted in standardization, in 1949, of the new 90 mm., M3A2, which was a lighter, more lethal weapon with the new bore devices and a stronger breech mechanism. The new Arsenal developments on this weapon were so successful that Ordnance soon issued production orders to modify all 90 mm, tank guns to incorporate them. A portion of this work also, as previously mentioned, was done at Watervliet.

The new 90 mm. gun was an example of a new design principle, as were the 76 mm. light tank and 120 mm. heavy tank weapons being worked on at the same time. This new principle was that a weapon of specific caliber and characteristics should be selected to perform a specific mission and then a complementary vehicle should be designed around it.

The 76 mm. light tank cannon progressed satisfactorily and engineering and firing tests of three experimental models continued into 1950. The 120 mm. heavy tank gun, designed to use a deadly high velocity armor piercing round of ammunition, marked a manufactur-

ing milestone. The weapon was of jacketed construction but for the first time in this method, the jackets and tubes were made interchangeable. Formerly, the jacket and tube for each weapon had to be tailor-made. Pilot models of this gun were completed and test firing began in 1949. However, new requirements stipulated that the gun be made lighter. Drawings of the redesigned weapon, now more than 1,000 pounds lighter, were released for manufacture in May, 1950.

Watervliet Arsenal had, at first, only the production and procurement end of the recoilless rifle program, while Frankford Arsenal carried the main responsibility for research and development. However, in 1947 Ordnance decided to end the division by consolidating the whole mission at Watervliet and design and development work was carried out at the Arsenal on the 57 mm. and 75 mm. recoilless weapons after this time. The situation underwent another change in early 1950 when the primary responsibility for these weapons was returned to Frankford by the Office, Chief of Ordnance. Though this step was taken because Frankford was found to possess certain experience and facilities available nowhere else, and because of the need to correlate basic research with development, Watervliet Arsenal retained its former role in the program, i.e., supervisor of the post-standardization industrial phase.

One of the largest research and development projects assigned to Watervliet in 1947 was the design and development of a series of self-propelled artillery weapons, one of the main facets of World War II medium howitzer, heavy howitzer and medium gun. There was a new approach also in the design of these weapons parallel to that in the design of the new tank weapons. These self-propelled guns and their complementary vehicles were to be designed just for this purpose, in contrast to the World War II practice, born of emergency, of adapting altered tank bodies to accept standard field

pieces. Thus a growing sophistication in the development of weapons systems was becoming evident.

The first of these weapons, the 155 mm. howitzer, again, planned to be lighter with higher fire power, was designed by a contractor under Arsenal supervision. It was completed in spring 1948 and later standardized as the M45.

The medium gun and heavy howitzer were to be as good or better than the towed standard 155 mm. Gun, M2, and the 8-inch Howitzer, M2. These two large weapons were to be capable of being mounted in the same vehicle and were to be able to use the same ammunition as the older towed models. The designs of these weapons, which in the event proved quite similar, were begun at Watervliet Arsenal in early 1947 and all drawings were released for manufacture by September of 1948. Prototypes of the 155 mm., T80, Gun and the 8-inch, T89, Howitzer, as the two new weapons were designated, were completed in November, 1949, and proved most successful during long test firings at Aberdeen Proving Ground. The few defects uncovered were minor and quickly corrected.

There were also continuous programs carried on through the period to produce an improved 81 mm. mortar, from which evolved weapons lighter in weight with greater range and firepower. Arsenal development of the 105 mm. mortar progressed through prototype construction but was hampered by ammunition difficulties.

The need for a lightweight weapon to defend airborne troops against enemy armor caused Watervliet Arsenal to receive orders to design and develop a 76 mm. cannon to be towed and airtransportable. Pilots were made in May of 1950 but difficulties were encountered with the breech mechanism and the weapon underwent extensive testing at Aberdeen and by the Army Field Forces during the summer of 1950. Considerable research and engineering activity on heavy antiaircraft guns produced the

120 mm., M1E1, in 1950. The original weapon was the 120 mm., M1 of World War II, but the superior weapon produced by the Arsenal engineers corrected many defects in the breech and firing mechanisms of the earlier model.

General Hughes had said in a speech to the American Ordnance Association in neighboring Troy that inventions were created by "turning wild men loose on ideas." The Arsenal scientists and engineers were not quite wild men but that their inventiveness could be brought to bear, with effect, on the problems of Army weaponry, there could be no doubt as the maturation of the design and development of these weapons in 1950 showed.

Yet manufacture of the new weapons presented certain new problems, since in order to achieve the desired high quality in these guns, new difficult-to-work metals and other materials had to be employed and new processes of manufacture had to be developed.

In meeting this challenge, the Arsenal also made important new beginnings and significant advances in the post-war years. During this period, after experimentation and investigation, several new processes designed to make guns better, more economically and faster were introduced into the Arsenal. Important among these were precision shrinking by induction heating, chrome plating, gun drilling and expanded precision casting.

The resistance method of heating guns, introduced in 1945 for shrinking and unshrinking of built-up cannon barrel members, was adequate but costly and time-consuming. Therefore, Arsenal engineers began in January, 1947, to investigate the application of induction heating to this cannon-making process and used it experimentally on a number of cannon barrels. The process required that the objects to be heated be placed inside a metallic coil through which a high frequency alternating electric current would be passed. This would cause a rapidly alternating magnetic

field, thus making the object in the coil a short circuiting agent which would heat very rapidly. The method had been applied in private industry and so representatives of private firms who used it were called in to assist in its application at the Arsenal. These men concluded that it could not be used in cannon making because of the huge coil that would be necessary to heat a cannon barrel. Arsenal engineers, however, conducted extensive further studies and experiments and decided that the method could be used, and in some cases would cut the heating time to one-eight that of the old resistance method. This would provide large monetary savings and increase production potential.

Through frequent consultation with General Electric Co. experts, the heating system was designed and G.E. of Schenectady was awarded the contract. The first elements of the complex equipment were received in November, 1948, for installation in the south end of Building 135, where preparations

TRAINING — Training has always been a major element in the gunmaking business.

had been in progress. Installation of this apparatus, intended mainly for shrinking and unshrinking 8-inch and 240 mm. tubes, was complete in June, 1949, and after extensive testing and adjustment was committed to manufacturing use.

A concurrent effort towards improvement of the shrinking process was taper honing of jackets for built-up guns to ensure a better fit between the gun jacket and tube. To supplant the old slow method of passing a series of reamers through the jacket bore, Arsenal engineers devised a new method wherein the jacket would be held firm and a number of honing heads would be passed through the bore. It was through their experimentation that major advancements were made.

A machine was developed that would not only produce the proper taper with an expanding honing head but, in addition, incorporated an electro-mechanical sizing device which quite accurately measured the taper which resulted.

In early 1947 also, Arsenal research and development men, seeking a means of countering erosion and corrosion of gun barrels due to weather and firing, began to experiment with chrome plating. Chrome was especially suited to this need since it was hard, of smooth finish and resistant to corrosion. The industrial requirements planned for a chrome plating system were that it should be able to handle a variety of guns up to the 16-inch; be completely controllable; should plate uniformly and consistently; should be economical of space, cost and maintenance and be safe and simple to operate. The Arsenal Service Division undertook the design of all the structural equipment, elevating mechanisms, tanks, exhaust systems, special pumps for the chromium solutions and electric generators necessary to meet these requirements. By November, 1947, 75% of the equipment was on hand at the Arsenal and work continued on the project through 1948, including manufacture of some of the

equipment at the Arsenal.

The use of precision casting at the Arsenal underwent a steady expansion following the war. It grew from a laboratory to a small production unit as the personnel continuously improved the operation with new techniques. It provided not only a source of good ordinary castings, but also became an alternate method of acquiring other parts difficult to machine. Drilling techniques were also improved during the post-war years. An important advance was made in 1949 with the application of carbide gun drills for cutting new high strength steels. One of the first uses was in cutting small deep holes in a 20 mm. bolt body which reduced the machining time to one-sixth and saved hundreds of thousands of dollars, in addition to doing a much better job. This method, as with many of the others the Arsenal developed, brought many visits and requests for information from private companies and was adopted as an entirely new manufacturing technique by American industry.

Indeed, the Arsenal was a much visited place during these years. For, in addition to the commercial visitors and those seeking specific information on processes, there were many visits by military representatives of friendly nations, such as Denmark, Turkey, Canada, France and England and students of technical schools. Also, groups of cadets and instructors from West Point usually visited the Arsenal once or twice each year. The largest groups of visitors, however, were the citizens who came to the Arsenal on public holiday "open houses." The first of these was Army Day in April, 1949, the first occasion for opening the Arsenal grounds since the war. Despite the fact that "the day was dreary with a fine drizzle," 1,300 people came to inspect the shops, grounds, and displays. The crowd was even larger in May, 1950, when 1,500 people came to take part in the Armed Forces Week program open house, which featured a band concert that had to be held in the cafeteria because of another steady

rain.

But, again, the search for and development of new processes in cannon manufacturing presupposed the use of new modern facilities to put the new methods into practice. Therefore, modernization of the Arsenal's manufacturing equipment became a necessity. This activity was slow immediately following the war but was fairly continuous and grew as time passed. From 1946 onward, most of the improvements were in the Big Gun Shop, Building 110, where machines were relocated, gun lathes lengthened, old equipment replaced and better foundations and beds were constructed for the huge boring and rifling machines. These latter, particularly for the 16-inch gun, were much improved as they were converted to better drive, lubrication and cooling systems. Some lathes were converted to be able to machine liners and jackets up to 68 feet in length and were fitted with new tapering equipment. The tapering equipment was completely installed by January, 1948, and the units performed with the "utmost precision" during tests. By late 1948 the heat treating shop in Building 110 had been equipped with anodizing, parkerizing, parco-lubriting and chrome-plating equipment. This chrome plating unit was intended primarily for smaller objects up to and including 3-inch and 90 mm. tubes.

Another piece of equipment reactivated at the Arsenal in 1948 scored a triumph only a month after it began operating. This was the Arsenal broadcasting or public address system. With speakers in all the major installation buildings, it had made a modest debut in October with a talk by the Commanding Officer on fire prevention. In the next few weeks it was used for similar instructive talks and for programs of news and music during lunch periods. The year 1948, however, was a presidential election year and although the results of elections are usually definite by the time Arsenal workers arrive for work in the morning, it was not true that November. With

the permission of Colonel Rising, the election returns were broadcast periodically over the Arsenal system the next morning until it became certain at about 11:00 a.m. that President Harry S. Truman would continue in office for another four years.

Work was also begun in the spring of 1949 to install the huge new honing machine in Building 110. This machine was designed to handle pieces up to 36 inches in diameter and 70 feet in length. When installation was complete in June, 1949, the overall length of this important piece of equipment was 192 feet. The machine received its first actual use that December and Colonel Rising wrote that "the work of honing the first 240 mm., T1, tube was accomplished with excellent results."

While the large excavation, electrical, steam and other work connected with installation of the heat treating equipment in the south end of Building 135 and the modernization of the heat treating and other equipment in Building 110 was fairly considerable in view of the general pace of the time, it was, one supposes, not very much in comparison with the large construction programs of World War II. Indeed, construction and maintenance of the Arsenal's buildings and grounds was at quite a low level in the post-war years. Maintenance in general-painting, roofing, roads and grounds work-was rather marginal despite frequent complaints by the commanding officers that there was a large need for these things. Some painting and repaving of streets was accomplished during shutdowns but this was minor.

It is important to note that although times were sometimes lean, the Arsenal never closed for lack of work. Besides vacation or holiday shutdowns during July, 1947, and July and December, 1949, there were only two occasions when circumstances threatened to close the Arsenal. Each time, the reason was a coal strike: the first did force the close of operations from December 20, 1946, to January 6, 1947,

because of lack of fuel but the effect of the second national coal strike and resulting fuel shortage in February, 1950, which curtailed industry across the nation, was thwarted by the Arsenal.

The situation grew serious at the Arsenal, then approaching the stride of its revival from the post-World War II slump, as repeated requests for coal were not filled and the supply on hand dwindled to only enough for 30 days. Steam pressure had been reduced in order to make this last, when urgent inquiries in Washington revealed that there were 1,600 tons of coal stored at the Voorheesville Depot, only a short distance from Watervliet. With the help of equipment loaned by the Voorheesville Depot and Schenectady General Depot, a sort of "truck-lift" was begun and 1,300 tons of the fuel were hauled to the Arsenal in a short time. The threatened shutdown was thus averted.

With increasing sophistication of the weapons designed by the Arsenal researchers and the complexity of the machines and processes required to produce them, there arose also a great need for closer control of the quality of the work turned out in the Arsenal shops. To be sure, the skills of the Arsenal craftsmen were second to none, but the increasing exactitude required to make the new weapons created an added strain on these skills. Thus, the introduction of scientific quality control methods into cannon manufacture in May, 1948, was one of the most significant events of the post-war years. Earlier in the year Arsenal personnel began to attend courses of lectures on quality control and to visit private factories where the system was in effect.

It was believed that these methods of precise gauging, in-process inspection and work charting would make it possible to avoid many work defects or discover them early enough to keep them from becoming serious. In May, the first few Manufacturing Department jobs were charted, i.e., the work was checked and measured, maxi-

mum and minimum standards were established and the workmen given a median line to aim for. This proved quite successful and the number of jobs to which quality control was applied began to grow each month. In October, 1948, the first attempt to calculate the effect of these procedures showed definite cash savings of $13,875 for 11 jobs over a six-month period. This was in addition to the intangible benefits of elimination of wasted man and machine hours and difficulties avoided before they occurred.

Accompanying the expansion of the number of jobs being charted was a program of education of both the machine operators and the supervisory personnel in the principles of the system. The practice of explaining to the workers just what quality control involved, early won their confidence and cooperation. Soon operators were charting their own work and looked for charts when starting new jobs. The Commanding Officer noted in June, 1949, that work from areas where the operators charted their own work had "improved considerably."

In 1949 also, quality control went into new phases such as classifying defects of work, setting standards for lot quantities and forming acceptance sampling plans. Also the methods were applied to materiel obtained by contract so that Arsenal planners could know in advance what quality of work a company could supply. The number of Arsenal operations controlled rose from 28 in January, 1950, to 75 in April, to 111 by June.

August, 1949, marked a milestone in another and older Arsenal "quality control" program. In that month the Arsenal apprentice program celebrated the tenth anniversary of the inauguration of its modernized organization. By this date, despite the vicissitudes of war and the Selective Service, 143 Arsenal apprentices had completed their training and received certificates. Eighty-nine of these men, or nearly two-thirds, were then employed at the Arsenal and many had

advanced to positions of considerable responsibility.

Earlier that year 38 Arsenal apprentices had celebrated another red letter day on the occasion of their "second" graduation from the apprentice school. At these ceremonies in May, the already graduate machinists were awarded New York State Journeyman Certificates of Completion by the New York State Apprenticeship Council. The granting of these certificates marked the formal approval by the state of the Arsenal's Apprentice School standards. The 38 machinists had already been graduated under a preliminary approval.

The year 1949 also held another but less auspicious "milestone" for the Arsenal. "September will be remembered by many employees as the month for cutting personnel at Watervliet Arsenal" was the rather gloomy description by Colonel Rising of the jolt the Arsenal suffered in September, 1949. The circumstances were familiar to old Arsenal workers: the Department of Defense wanted to cut down the number of its civilian employees and Watervliet Arsenal was ordered to cut its strength to 1,176 by October 23. This meant separation of 308 employees, as the force was then 1,484 persons. However, in the event, only 240 people were RIF'd and the Arsenal's strength at the end of the year was 1,244 persons.

But if the Arsenal was losing quite a few men through RIF's, by and large, it was not losing many through accidents. Colonel Raaen had proudly announced in 1947 that Watervliet Arsenal was reversing the upward trend in industrial accidents which followed V-J Day, and although there was an increase during 1949, Colonel Rising was able to write in early 1950 that the Arsenal accident frequency rate was below the national average for machine shops and the severity rate was less than one-fifth, according to U. S. Department of Labor figures.

The tone of the Arsenal's activity for the new year 1950

was set early in January General Omar N. Bradley, Chairman of the United States Joint Chiefs of Staff, commented on the rearmament needs of the U. S. and its allies in the face of increasing world tensions and threats from the communist bloc nation.

General Bradley, in the area to speak at a local college, declined to say specifically what general rearmament would mean to the Arsenal, but he did point out that surplus items would be going to the nation's allies and active units would be drawing on reserves. To replenish these reserves and fill the increased demands for arms, "much will have to be manufactured," the General said.

The beginning of the influence of the general rearmament on the Arsenal has already been seen in the somewhat increased production schedules; but Watervliet Arsenal was now mainly a prototype manufacturer and the main burden of cannon production was to lie with private industry, as supervised by the Arsenal. Procurement spending by the Arsenal, therefore, rose sharply in the first six months of 1950. During the last half of 1949 about $1,300,000 had been spent, but in the first half of 1950, the outlay for procurement grew to $3,400,000. Contracts were let to set up grinding facilities, mass production equipment for the 90 mm. gun, facilities for the 81 mm. mortar and ammunition belt links for the 20 mm. automatic. Through these months many visits were made to private ordnance producers by Arsenal representatives who inspected production and engineering facilities. The Arsenal continued to send special costly machines to these producers, as well as men, as the national mobilization base began to undergo reconstruction. The Arsenal's own manufacturing facilities were surveyed to determine their mobilization potential and frequent requests were made to the Office, Chief of Ordnance for M-Day assignments.

With the increases in activity the Arsenal work force

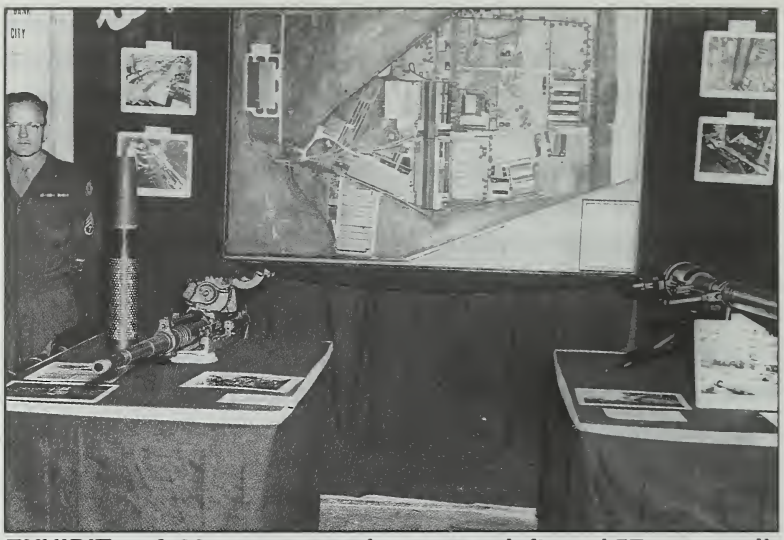


EXHIBIT — A 20mm automatic cannon, left, and 57mm recoilless rifle are displayed at Watervliet Civic Center in 1949.

rose through the first months of the year and by the beginning of the summer, the Arsenal employment rolls listed 1,505 persons and the ceiling allowed for 170 more. A survey was made of the skills of 1,400 employees and 2,000 applications for employment were reviewed. The expenditures for the Arsenal in the first months of 1950 totalled nearly $5,000,000-over $1,000,000 more than was spent in all of 1947.

Wrote Colonel Rising: "June was one of the busiest months this Arsenal has had for a long time. Heavier than usual production schedules made it necessary to institute overtime in the shops and the necessity of closing negotiations for procurement by contract...made it necessary to institute overtime in the Planning Division. This increased activity stepped up the tempo throughout the who installation."

This livened tempo was felt strongly in the Arsenal training program. Training officers had reported that the RIF of 1949 "practically eliminated the group recruited in 1948 and 1949, thus nullifying our effort to

provide continuity to the training program." However, things were looking up as authorizations were received to hire more apprentices. Furthermore, another important aspect of the training program had reached a significant stage of development. Training unskilled people to work in gun production had been a major problem of World War II and based on the hard-won experience of those years, Watervliet Arsenal had made preparations for any new conflict that might arise.

Classroom facilities for training unskilled people had been completely revamped, a shop machine training unit established and the training course laid out completely except for minor details. In early summer 1950, training officials reported that the whole program could be activated in two or three weeks, if need be.

They were to be taken at their word.

Chapter 11
Korean War and the Growth of the Research Center

"Arsenal Cancels All Leaves, Gun Production To Be Speeded" screamed the headlines on July 14, 1950. With the Republic of Korea's troops reeling before the onslaught of the Russian and Chinese supported forces of North Korea, the President of the United States had gravely decided on June 26 to honor the nation's solemn commitments to that fledgling nation and the United Nations. Thus, after a fearfully short breathing space of less than five years, the United States was once more at war and Watervliet Arsenal was again called upon to do its part.

Colonel Rising went to Washington at once to confer with the Chief of Ordnance and other officials. Vacations were indeed cancelled and Arsenal workers who, only short days or weeks before, had left the installation, now reviving and with improved prospects of peacetime operations, eturned to find tightened security measures throughout the post and a grimness that even the bright weather of the northern summer could not dispel. It was recalled that it was almost ten years to the date from the beginning of the speed-up just preceding World War II.

On the Colonel's return the next day, he announced that the Arsenal had been ordered to begin production of new tank weapons "as soon as the wheels can turn." Calls were issued immediately for skilled machinists, machine tool operators, benchmen, warehousemen, freight handlers, and all the types of experienced personnel it would take to put the grate Arsenal machine in full motion.

To this end, ceilings on funding and employment were expanded and Civil Service regulations relaxed to permit Arsenal recruiters to make temporary and war service appointments.

One of the personnel officers later recalled: "The effective recruitment really began when 'open gate' hiring was started. Colonel Rising requested the newly-formed Employee Utilization Office to hire 100 people per day. This seemingly impossible task was so successful that, at one point, recruitment had to be halted until the shops could catch up and arrange for utilization of the people. Two hundred to 300 people were interviewed each day at the personnel office and about half of them were hired by the opeating officials. The efficiency of the interviewing staff led Colonel Rising to double its number from two to four persons."

By December, 10,000 applications for various jobs had been reviewed and the actual force had nearly doubled in a jump from 1,505 to 2,769 workers. The expansion was transmitted all along the line and many operating and manufacturing groups' staffs were nearly doubled.

The Arsenal training program became a vital facet of the great expansion. Mere numbers in the shops could not be enough; rather, well-trained men and women would have to operate the tools of production if the Arsenal's reputation for excellence and dependability at the fighting fronts was to be maintained.

Authorization was given to recruit 60 additional apprentices (42 were in training at the outbreak of war)

and new facilities were established in Building 40, where three new classrooms and a drafting room were fitted with movie screens, other visual aids and general equipment. Three learner classrooms were opened where large numbers of incoming workers were trained in the operation of milling machines, grinders, drill presses and other equipment. Modern visual aids were adapted to this program also and new employees were shown films on the use of various tools,safety and fire prevention. The ordnance inspector program also felt the impetus of the war as the inspector training period was extended from two to four weeks and classes were instructed in inspection procedrues for the 20 mm., M24, and 57 mm and 75 mm recoilless rifles.

Manufacturing concentrated on new fabrication of 20 mm aircraft or anti-aircraft weapons and the 90 mm gun for the medium tank. About 300 90 mm's and nearly 2,000 of the 20 mm's were shipped by the Arsenal Field Service Branch during the first six months of the war. Field Service, however, continued to handle a variety of materiel and also included on its shipping bills were two 13-ton tractors, 53 ammunition trailers and 19 light tanks.

But if the job of getting the Arsenal itself into condition to meet its vastly expanded wartime role was one to tax to the utmost the human resources of planners and workers, the task of mobilizing private industry for national defense presented almost superhuman problems. That this was done and done as quickly and well as it was can be one of Watervliet Arsenal's proudest boasts.

Since at the end of World War II mobilization planning was, for all practical purposes, allowed to deteriorate to a mere paper study and all government-owned facilities were either declared excess or the equipment stored without relationship to planned end item or facilities, the outbreak of war presented a crisis of the first magnitude.

The Dickson Gun Plant was only used for storage of machine tools, while both

Ridgewood Ordnance Plant and Lima Ordnance Steel Foundry had been placed on the excess list. Fortunately no buyers had been found for either of these facilities and while for the most part their machine tools had been stripped, the buildings themselves and the non-removable equipment remained intact.

The price of the "boom and bust" attitude in defense production now had to be paid. It was necessary to begin almost completely from scratch in reviewing the lists of machine tools in storage and requiring that known producers visit the storage sites to inspect and select equipment which could be used to manufacture the needed items.

Since orders were received on a piecemeal basis, "first-come, first served" became the rule of the day and, in most cases, production lines were set up with tools which, in large part, were not the proper ones for the job.

A really critical phase of industrial mobilization was the fact that from the closing of the Cannon Sub Office at the end of World War II to the outbreak of fighting in Korea there was no national procurement unit at the Arsenal, and there were thus very few people with the knowledge necessary to get production started at outside facilities.

For this reason it was extremely difficult to estimate the funds needed for rehabilitation and procurement of production facilities and when this data was requested, a hurried estimate of $25,000,000 was made. With the press of wartime events, this amount was granted by teletype from the Office, Chief of Ordnance.

Procurement of the vital forgings necessary was a serious obstacle. It became necessary on receipt of gun requirements to call a meeting of all known forging producers to find out their capacities for production of the various sized tubes. The meeting resulted in a prospective distribution of orders which was later made concrete through the various ordnance districts. In many

cases the forging producers went ahead with only verbal instructions — a measure which probably saved two or three weeks of vital production time.

In these first explorations of the forging potentials of the various producers, it quickly came to light that their capacity for either tube or breech ring forgings was not sufficient.

This crucial deficiency resulted in the expenditure of $17,000,000 at the Bethlehem Steel Company to expand capacity by a number of forgings equal to 1,200 90 mm forgings per month and expenditure at Cameron Iron Works of $12,000,000 to set up breech ring forging facilities which would be capable of 4,000 90 mm forgings per month.

The facilities established at Bethlehem Steel present an ironic example of the high cost of unpreparedness in national defense; for these vastly expensive facilites, begun only at the moment of the arrival of the crisis, were not ready to operate until the emergency was over and produced only a pilot quantity of forgings to test the equipment.

An additional problem which developed in the early weeks of the war was the increase in the required yield strength of the tube forgings from the World War II standard of 100-130,000 yield strength to the much higher level of 160-190,000 yield strength. A charpy impact requirement had also been added. Until this time, forgings equalling these requirements had been produced only experimentally and until the manufacturers learned the necessary techniques, it was largely necessary to place contracts on a "best effort basis."

Finish machining the guns during the Korean War did not present such great problems as did the forgings, yet it was required that the bores of the new weapons by chrome-plated for longevity, accuracy and ease of cleaning. The difficulties involved in this operation finally resulted in institution of government facilities in three plants to handle the chrome

plating on items from all the private finish machining producers.

Twenty-nine private corporations were employed by the Arsenal throughout the conflict in meeting the requirements of mobilization. The contribution of the Arsenal in coordinating this vast effort, supplying advice, equipment, and training was truly significant.

One interesting sidelight to the mobilization and expansion of the Arsenal in the emergency was the activation of part of the 9388th Ordnance Reserve Technical Service Unit. The unit was organized after the end of World War II with headquarters at the Arsenal. It was composed of area business and professional men in the belief that their opportunity to keep themselves continually abreast of developments at the Arsenal would be valuable in time of emergency, i.e., they would be able to fit into the Arsenal organization with a minimum of briefing or training. Four offices of the unit were assigned to the Arsenal a few months after the outbreak of the war.

As the new year 1951 approached, expectations of continued increases in force were high and plans were laid to put the Arsenal operating units on a six-day work week. Some units were already working six days and others were placed on this schedule for the first several months of 1951. However, the seven-day work week of World War II was not generally adopted, since it had been found inefficient and unduly tiring for the workers.

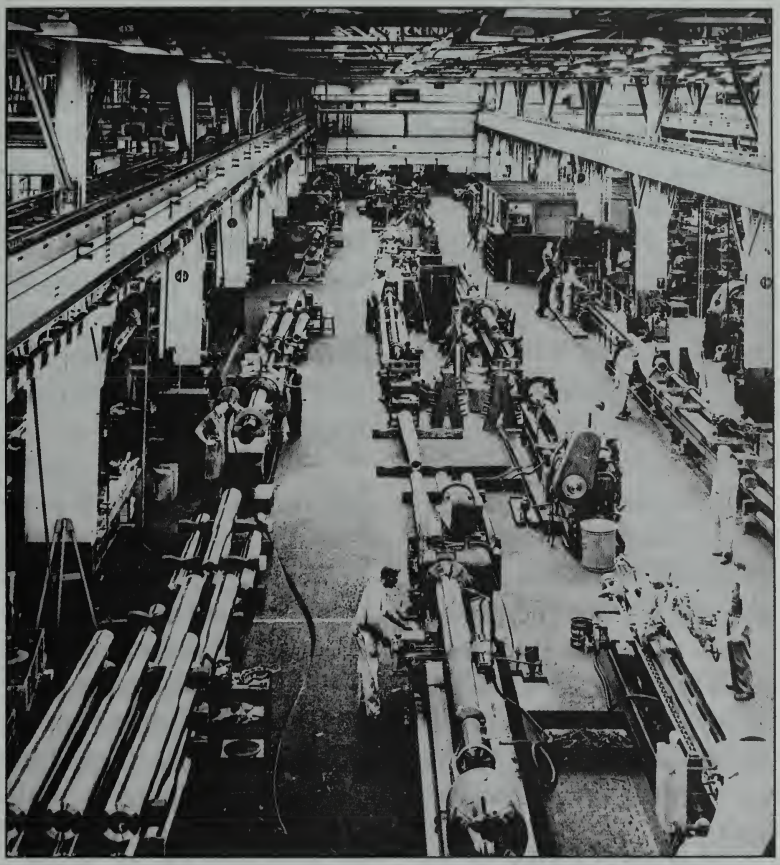
In those months the number of women in the Arsenal shops was increasing. The return of the women workers to the Arsenal and other defense industries was described as a "rush" and their attitude was called "super eager." The speculations as to why they returned were many. It was offered that they returned for the money the could add to family incomes, since living costs were rising rapidly; that they sought companionship or a feeling of independence. That some at least were motivated by the opportunity to serve

their country seems never to have been considered — a not inconsiderable slight. That the women workers performed their Arsenal duties very well during the Korean War — and many returned to the same machines and cranes at which they had served during World War II — there can be no doubt. In answer to the question as to why they performed such difficult jobs as the operation of heavy cranes so well, one Arsenal officer at the time gave the rather curious reply that they took orders better than men.

Plans for expansion of the Arsenal work force, made at the beginning of the year, were carried out. Calls for machine operators and skilled workmen continued to be frequent in the face of heavy production schedules. By June, 1951, there were approximately 4,300 workers of all types on the Arsenal rolls. At the end of that month the approximately 3,800 workers with hourly pay rates received a small increase in pay as the result of the annual area industry wage survey. While the amount was small, these workers had received a raise of about 8% the previous year.

One problem attendant on the increase in employment was caused by the fact that most Arsenal workers at this time owned automobiles and drove them to work. Not inconsiderable parking problems resulted in the city streets around the Arsenal, which brought protests from the Watervleit city officials. The difficulty was somewhat eased by the opening of a new Arsenal parking lot in the former river wharf area on the east side of Broadway.

That Civil Defense was a prime concern in these wartime months was seen by the huge turn-out for the Arsenal Civil Defense rally in late August, 1951. Approximately 10,000 Arsenal workers, families, and friends attended the event which lasted from mid-afternoon until late in the evening. While there were serious demonstrations of procedures to be followed in the event of enemy attack, the rally also provided an occasion for relaxation from the strain of war work and



120MM SLEEVE — View of the post-World War II 120mm sleeve line.

took on the air of an old fashioned picnic, complete with refreshments, dancing and a fireworks display.

The heavy pace of production in the Arsenal shops, and procurement through facilities in private industries continued through the succeeding months of the year. And as the year approached a close, Arsenal workers earned a mark of distinction. In December, 1941, the Arsenal was awarded the coveted U. S. Treasury "Minute Man" flag for the highest participation in the payroll savings plan for buying defense bonds of any installation in

the First Army Area.

The high water mark of Arsenal employment and production during the war was reached shortly after the beginning of 1952 when there were 4,850 persons employed. The first signs of a slackening of the pace followed shortly.

In late February, the Arsenal returned to a five-day work week. Arsenal officials explained the shortening of the work week as an economy measure. They pointed out that the organization of defense work had been completed and that while production would not be cut, the current load could be handled by a five-day schedule.

Following quickly on the heels of the reduced work week was a cut of 100 temporary machine operators and shop workers. Colonel Rising explained that the reduction was necessary due to the expansion of the munitions producing facilities in industry and subsequent alteration of the primary Arsenal role from that of a heavy producer to one of an advisor and consultant. The Colonel also predicted that an easing of the overseas demands due to less critical situations could result in further reductions in the working staff. He asked for a voluntary return to private industry by the many temporary workers (about two-thirds of the total employment) in order to avoid a major RIF.

On September 1, 1952, the Arsenal received a new Commanding Officer. Colonel Richard Z. Crane brought to the Arsenal a background of nearly 35 years of service and wide and varied experience in the development of modern heavy weapons. Colonel Crane held both graduate and undergraduate degrees from Harvard University and was a graduate of a number of Army special schools.

He began his Army career as an infantry second lieutenant in 1917 and entered Ordnance in 1921. He served as an ROTC instructor, had seen service in the Philippine Islands before World War II and held several positions in the Office,

Chief of Ordnance, ordnance districts and arsenals. The colonel had served as ordnance officer for three armies in the European Theater during World War II and for the four years previous to his assignment to Watervliet, he served as chief of the Artillery Branch of the Research and Development Division of the Office, Chief of Ordnance.

Colonel Rising, who had commanded the Arsenal through the difficult period following World War II and the hectic days of the emergency mobilization at the beginning of the Korean War, left the Arsenal August 26, 1952, on temporary assignment to Philadelphia Ordnance District to await completion of processing of his retirement from the Army.

It was a testimony to his popularity with the employees that 300 persons attended his farewell dinner, which was prepared by women workers and wives of some of the Arsenal men.

One example of the fact that while the Arsenal was spending millions of dollars each month, economy continued paramount occurred in September of 1952. In this instance savings of nearly $1,000,000 were effected by heat treating and reworking several hundred 155mm. howitzer forgings, stored at the Arsenal since World War II, to the higher specifications necessary. Other savings reported at this time were $72,000 worth of nickel recovered from machining scraps and a total of $100,000 saved through improved processes, time study, and quality control.

The motivating spirit behind the efforts of the administrators and workers of the Arsenal in these months of war was well put by Colonel Crane in an address to a local civic group:

"I can still remember the training days of World War I," the Colonel said, "when our soldiers trained with broomsticks for riles and logs for artillery...when we were furnished with weapons the rifles were the English Enfield while our artillery was predominantly French-made." He stressed "the pro-

found obligation to insure that our boys in the military service have the most advanced and effective weapons that can be produced."

The Arsenal received two pieces of good news at the change of the year: at the end of November, 1952, 3,000 Arsenal workers received a six-cent-per-hour wage increase which was retroactive for about six weeks and in January, 1953, an Arsenal apprentice was selected as the outstanding apprentice in New York State.

Mr. Joseph Ropitsky, a last year apprentice machinist, was chosen from 28 statewide finalists by a distinguished committee of industrialists, educators and apprentice specialists. A total of 225 apprentices had graduated from the Arsenal program to that time and there were then 93 in training. The quality of the Arsenal program and its wide reputation were well attested to by Mr. Ropitsky's honor.

In February, 1953, announcement was made of a new and highly sophisticated weapon in the development of which the Arsenal played a major role. Dubbed "Skysweeper," the system consisted of a 75mm anti-aircraft gun and radar-controlled fire direction equipment integrated in a single mobile unit. Colonel Crane explained that working as a team with Watertown and Frankford Arsenals, Watervliet had aided in development of the weapon and had carried out prototype production until facilities in industry were ready to assume the major production of the gun.

The gun and control system were capable of being placed in action in five minutes. The gun had a 45-round-per-minute rate of fire and was highly accurate against single or groups of aircraft flying at near sonic speeds and low or medium altitude. Effective day or night, regardless of weather conditions, it could also be used against moving ground targets such as tanks.

Hardly a month after the announcement of the Arsenal's role in the new Skysweeper, the Arsenal

burst into the field of atomic weaponry with the roar of a 280 mm atomic artillery shell exploding over the Nevada desert on May 25, 1953.

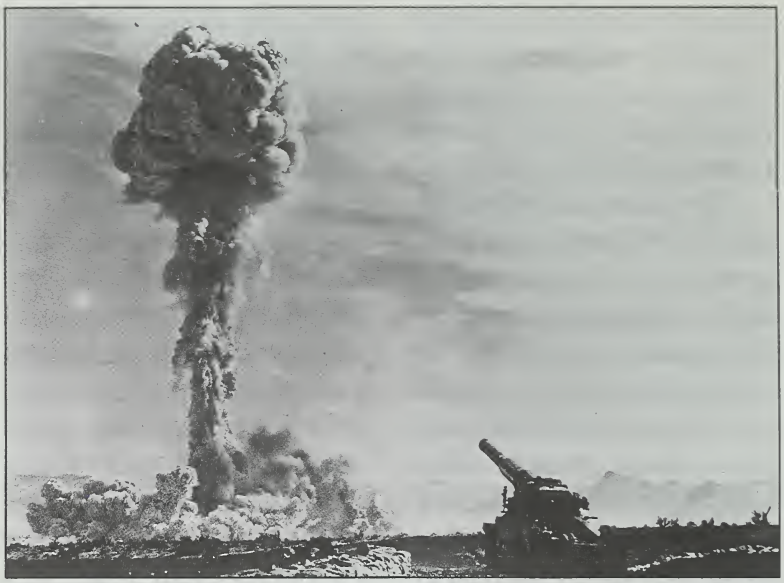
The blast, witnessed by a party of 60 members of Congress and a large party of high-ranking government officials and newsmen, 500 feet above a large group of military targets was the culmination of seven years of effort by Army researchers, scientists, engineers and manufacturing specialists, throughout which Watervliet Arsenal had played a prominent part.

The Arsenal's role in the weapon had first come to public attention almost a year earlier through a speech given by Major General E. L. Ford, Chief of Ordnance, to a Massachusetts unit of the American Ordnance Association. Newspaper reporters and photographers were allowed to view some of the manufacturing operations at the Arsenal in early October, 1952, and interest in the weapon ran high after Colonel Crane and Arsenal officials reported on firing demonstrations at Aberdeen Proving Ground two weeks later. On this occasion officials were shown the mobility of the weapon which was transported between two power tractors and could be emplaced in 15 minutes. The weapons performed with great accuracy at 12 miles' range and it was explained that at 35 degrees' elevation, the 280 mm atomic guns could fire accurately at targets 20 miles distant.

At the Frenchman's Flat demonstration of the weapon's atomic capability in spring, 1953, the range was kept to seven miles. The force of the explosion of the atomic shell was only about one third less than that of the atomic bombs which demolished Hiroshima and Nagasaki during World War II.

It was reported by observers that about half of the 16 pieces of railroad equipment in the target area, including a 45-ton diesel locomotive, were toppled by the blast and those left standing had suffered various degrees of damage.

When Colonel Crane re-



ATOMIC GUN — Test firing of the 280mm, M66, cannon, known as the "atomic gun."

turned to the Arsenal two days after the demonstration, he was still trying to collect his reactions to the spectacle: "It was the most awesome thing I have ever seen," the Colonel said. "With a prearranged schedule determined to split-second accuracy, the gun designed and manufactured by technicians at Watervliet Arsenal placed the projectile with a remarkable degree of precision...We had confidence in our calculations and all our years of study and design but only the firing could prove we were right."

Yet, while the Colonel and all the Arsenal people were pround of their contribution to the nation's defense, he expressed the feeling of all those charged with safeguarding a powerful but peace-loving nation in remarking: "We have created this great weapon and we have got to use it intelligently — that is something for everybody to think about."

The long and bitter fighting for the hills of Korea finally came to an end at 10 p.m., July 27, 1953, after a long and equally bitter

struggle at the conference tables. The end of the fighting brought no ceremony or celebration at the Arsenal, or in the area, such as had occurred at the close of previous conflicts. The work of the Arsenal went forward with no slackening of pace.

A few months later, in September, the first of the 280 mm Arsenal Atomic cannons were sent to Europe to be integrated in the defense of the NATO nations. The unit was the 868th Field Artillery of Fort Bragg, North Carolina, which was scheduled for stationing in West Germany. It was the first of several units armed with these weapons moved to Europe in long-planned move to strengthen western defenses.

In October, the Arsenal began to feel the pinch of post-war defense reductions as 100 machine operators were separated, as had been predicted by Colonel Crane the previous summer. Contracts had been completed which had not been renewed and there were economy moves under way within the Department of the Army.

With end end of 1953 came the end of a minor era at Watervliet Arsenal. "Billy," a 19-year old bay gelding, the last horse used at the Arsenal, was disposed of. Instructions had been received to dispose of both Billy and Pete, his harness mate, about three years before, but at the Arsenal's request, temporary permission had been granted to keep them. Pete had succumbed in 1952 despite attempts to save him and in December, 1953, Billy was declared excess to the needs of the Arsenal. Arsenal officials requested permission to sell him but it was denied. Instructions regarding his disposition said it was generally considered more humane to destroy animals of Billy's age rather than to sell them to persons who might mistreat them. With the passing of Billy, the horsepower era at the Arsenal, probably begun in 1813, came to an end.

There was, however, less nostalgic news for Arsenal workers at the end of December, 1953. It was announced that a gradual reduction in force of the Arsenal staff

would begin at once and continue for several months. Ordnance Department officials in Washington predicted that the employment cuts would be "pretty high" and cited improvements in the defense stockpile, the fact that the Arsenal had been catching up on ots orders, and defense budget cuts as the reasons. On January 5, 1954, the expected RIF procedures were clarified when Colonel Crane announced that one-half of the Arsenal's 4,000 workers would be separated in the next six months. The Commanding Officer explained that "the cessation of active hostilities in Korea, together with a popular demand for a substantial reduction in government expenditures has resulted in a reappraisal of production requirements for national defense." The colonel pointed out that the decision to reduce the force by 50% was the result of a study to determine the maximum number of employees which could be kept for the longest period of time. Barring further cuts in defense requirements, he said, a force of about 2,000 people could be maintained for the 12 months following completion of the reductions.

The announcement of the Reduction-in-Force brought many protests from area Representatives and Senators in Washington and meetings with Department of Army and Department of Defense officials continued through the next few months. Attempts were made to secure more work for the Arsenal and, in particular, to introduce segments of the developing atomic weapons program into the Arsenal area of operations. The latter efforts were without success but the employment cuts were alleviated somewhat. By February, employment had dropped to about 3,600 persons; by March, about 3,200; in April, about 3,050, and in May, about 2,800. The planned number for June was to be about 2,500 persons but as that month arrived there were still 2,775 persons on the Arsenal employment rolls. Further, orders were received for a large number of 280 mm guns in June, which

promised to stabilize employment at the June level for about the next year.

At the end of August, 1954, Colonel Crane retired from the Army after 37 years' service in the Ordnance Corps. Major General Emerson L. Cummngs, Chief of Ordnance, praised Colonel Crane's part in the development of the Atomic Cannon, at the Colonel's farewell dinner. Colonel Crane's ability to maintain high morale in spite of reduced operations was also praised.

The new Arsenal Commanding Officer, Colonel Elmo S. Mathews, toured the Arsenal a week before Colonel Crane left, although he did not take command until late in September. The Colonel, however, was familiar with the operations of the Arsenal from the days of the speed-up for the Korean War, when he had been a frequent visitor in connection with his duties in the Artillery Branch of the Industrial Service, Office, Chief of Ordnance. A native of Arizona, he had resided in California for several years and was appointed to the U. S. Military Academy from that state. A graduate of the Academy in 1928, Colonel Mathews had held several responsible positions during his service career and was ably suited to command of the Arsenal by his academic training which included master of science degrees from both the California Institute of Technology and Massachusetts Institute of Technology, as well as a master's degree in Business Administration from Harvard University.

In the short interval between the end of Colonel Crane's command and the beginning of Colonel Mathews', in late August, 1954, ground was broken for construction of the first major building to be erected at the Arsenal since World War II. The effort to acquire a new building to house the Arsenal's priceless gages and gage facility had been in progress intermittently for 10 years. General Gillespie had proposed the project to the office, Chief of Ordnance, during 1944 in anticipation of the return of millions of

BLDG. 44 — Built in 1967, Building 44 was constructed to house gages and, later, product assurance functions.

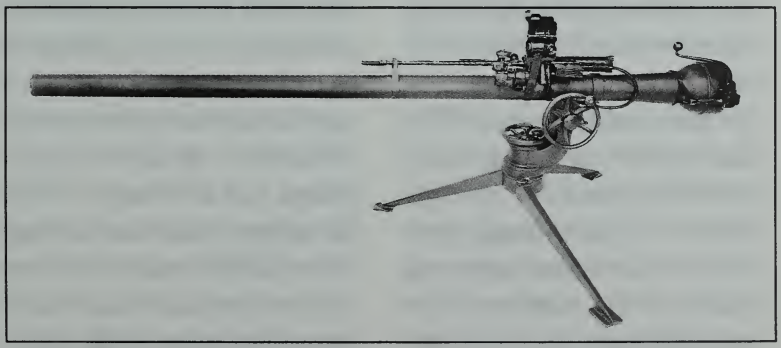
dollars worth of gages at the end of the conflict. The project had been turned down, as was a similar one by Colonel Partridge a short time later. The plan was revived, however, after the beginnign of the Korean War, when the gage facilities were still located in Building 105 (constructed in 1844 as a timber storehouse) and recommendations were again made for a building which would provide for more efficient operation, safer storage and needed expansion. After consideration and reconsideration by Congress on three or four occasions, $584,000 was allotted for the purpose. The new building was to be fireproof and provide approximately 37,000 square feet of floor space including a basement and first floor. A five-ton steel elevator was included from the basement to the first floor and provision was made for expansion to a second floor if necessary. Since the Arsenal was responsible for design, procurement and issue of all Ordnance inspection gages for cannon and components from 20 mm to 16-inch on a national basis, the addition of this facility was especially valuable and pertinent to its mission.

The unveiling of the "BAT" — for Battalion-Anti-Tank weapon in October, 1954, again brought the Arsenal to public notice as a

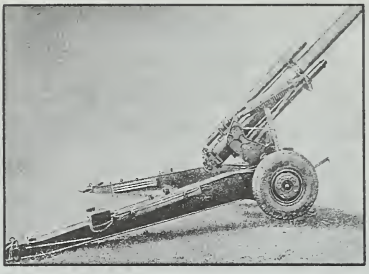
center of modern weaponry. A 106 mm. recoilless rifle, the weapon could be mounted and fired either from a jeep or from a ground mount, and a .50 caliber spotting rifle was included in the system. The Arsenal, which had made major components for the experimental models, conducted prototype production and received the national procurement responsibility for the weapon. Weighing less than 500 pounds, the BAT was designed to use a variety of ammunition deadly against the strongest armor and fixed emplacements.

The BAT had been under development since 1950 and the completion of the system in late 1954 gives an opportunity to consider the Arsenal accomplishment in weapons from the beginning of the buildup in 1950, through the Korean fighting to the end of the post-war phase in 1954.

During the period from January, 1950, to December, 1954, the Arsenal had manufactured approximately 20,000 guns, mortars, recoilless rifles and howitzers of 26 types. Most important of these were the 90 mm. tank guns of which nearly 4,000 were made in six models and the 20 mm. weapons, over 7,700 of which were made in two models. The Arsenal also produced approximately 1,600 of the 155 mm. howitzers which were a workhorse of the Korean War. The re-



"BAT" — The 106mm, M40A1 recoilless rifle. "BAT" stands for Battalion-Anti-Tank weapon system.



HOWITZER — Medium towed 155mm M114 and M114A1.

coilless rifles, in 57 mm, 75 mm, and 105 mm, and 120 mm. guns were also produced in significant quantities.

Yet, while the Arsenal's manufacturing record during this period compared very favorably with its performance during World War II, it is truly indicative of its modern role as an experimental, prototype, and limited quantity producer, that the total Arsenal output of guns was only about 14% of the more than 140,000 weapons produced in private industrial establishments. The total funds expended under Arsenal control for the operation of these hugh procurement programs give an outline of the activity of the installation during these important uyears.

In the opening year of 1950, $20,000,000 was spent in the procurement of weapons and spare parts, exclusive of research and development items; in 1951, this jumped $74,000,000 to a total of $94,000,000. In the peak year of the Korean War, 1952, procurement spending again more than tripled and mounted to $375,000,000 for that year. The next year, as stockpiles grew and the demands of the war lessened, procurement spending decreased by $219,000,000 to $156,000,000 for the year 1953. This total, in turn, was reduced by $72,000,000 to $84,000,000 for 1954 as the period closed.

The year 1954 also witnessed the culmination of a revolution in the manner in which the Arsenal maintained control of the huge amounts of money granted to it each year for the implementation of its role in defense programs. In February, 1954, the Arsenal was issued a charter and initial cash authorization by the Assistant Secretary of Defense which authorized commencement of operations under the Army In-

dustrial Fund the following March 1.

This major occurrence in the development of the Arsenal system of operations had its beginning five years before in the 1949 amendments to the National Security Act of 1947. These amendments directed the reorganization of fiscal management in the National Military Establishment in keeping with recommendations by the Hoover Committee on governmental reorganization. The influence of these studies and the legislation which followed was not felt at the Arsenal until 1952. Rumors were plentiful in the fall of that year that the Army had decided to install a new industrial managmeent and accounting system in its manufacturing plants and arsenals.

The only knowledge of the system — called the Army Industrial Fund — at Watervliet Arsenal was that a pilot project was taking place at another Ordnance Corps installation, Picatinny Arsenal. Information was requested from both the Chief of Ordnance and Picatinny and made available to key Arsenal people. Examination of the information quickly, and happily, showed that the new system promised a single source of funds and personnel authorizations and an end to the unwieldy comand system under which the Arsenal operated. That is, at this time, as for several years before, Ordnance Arsenals, including Watervliet, were more or less subject to dual commanders. On one hand, the Arsenal was responsible to the Chief of Ordnance for mission responsibilities, and, on the other, to the Commanding General of the area Army Headquarters, First Army, for support services such as reapirs, utilities, disbursing functions, transportation, communication services, and other items. The money and personnel authorization for these functions had to be approved by the Army Commander, with the result that the reporting and record keeping involved were voluminous and the controls were restrictive to an onerous degree. It was, as one Arsenal offical put it, "the time of

'twice-a-year' grass-cutting and 'air conditioned' shops, with the Post Engineer unhappily fixed between the Arsenal Commander and the First Army money and personnel source." An end to this arrangement promised to be most welcome to Arsenal officials.

Not long after receipt of the information on the proposed Army Industrial Fund, the Arsenal was deluged with representatives from public accounting and management engineering firms sent by higher Army organizations to study the Arsenal operations with a view to the feasibility of installation of the new system and, of prime interest to the firms, to establish a bidding price for the Ordnance Corps contract. It was soon announced that Watervliet Arsenal, along with the other Ordnance manufacturing arsenals, Springfield, Watertown, Frankford, Rock Island and Redstone, was scheduled for immediate installation of the new system. At a special Pentagon Commanders Conference shortly thereafter, the Chief of Ordnance ordered Watervliet's Commanding Officer, then Colonel Richard Z. Crane, and other Arsenal commanders, to establish comptroller organizations when they returned to their installations.

The Comptroller Office was established at Watervliet on December 1, 1952, and the rebirth of the Arsenal unit from a traditional Army fiscal office to a financial management office with responsibilities in budgeting, accounting, managment engineering and internal review stems from that date.

Howell & Co., the firm which had contracted to install the system at the Arsenal, began operation in May, 1953, and, after only a few days of briefings, it became apparent to all concerned that the Army Industrial Fund system would result in a complete upheaval of traditionally entrenched operations not only in the financial area, but in production planning, inventory control, work ordering and supply management as well. The contractor team embarked on a 10 month

scheduled program of systesm design, personnel indoctrination and training, procedural writing and related measures. Despite the tragic death of the contractor team leader in an aircraft accident in September, 1953, and other impediments such as old line oppposition to change, the inability to secure professional accounting and management engineering personnel and constant changes in policy from higher authorities, the work went forward.

In November, 1953, a considerable stir was occasioned at the Arsenal by the announcement that Watervliet had been selected as the representative Ordnance installation for study by the Cooper Committee, a task force of distinguished industrialists and financiers appointed by Secretary of Defense Charles Wilson to make a factual survey of financial conditions within the Defense Department. That the high level delegation was highly impressed and pleased with the strides that the Arsenal was making in production planning, labor control, engineered time standarards, and financial management, was evidenced in the group's formal report to Secretary Wilson. Of the topics discussed during the visit to the Arsenal, many formed the basis for the committee's recommendations in its formal report to the Secretary.

However, while operations under the Industrial Fund were formally begun in March, 1954, the difficulties of the changeover from the traditional system to the new, continued through the year. Chief difficulties were personnel recruitment, training older employees in the new system, lack of policy and procedural guidance governing day-to-day working problems and, particularly, recurring and "crash" reporting requirements. Working problems were further aggravated by almost daily visits from all echelons and services of the Defense Department, especially those which had been scheduled by the Defense Department for industrial funding also.

Another major new ef-

fort begun in t he second half of 1954 was the result of the experiences of mobilization during the Korean War and was to have far-reaching consequences in the Arsenal's future.

This was the beginning of a program of Congressional approval of sums of money on an annual basis, to assure the continued availability of an industrial mobilization base. These sums were included in the Department of Defense Budget for establishment, rehabilitation, modernization and other improvement of the production facilites required. Thus the Arsenal was able to engage in a long-range program of modernization of some of the larger buildings through rehabilitation, to replace outmoded utilities, to acquire multi-purpose equipment and to rehabilitate and replace many items of production equipment.

The first sum the Arsenal received under the program was the largest, $6,910,000, and provided the base for future developments. A survey and engineering study were conducted by a New York City firm of architectural engineers to determine the extent of the work needed for modernization of facilities to make the Arsenal a completely modern industrial plant. The report of findings, including descriptions, exhibits, plans, layouts and outline specifications, served as a guide for the improvements of succeeding years.

The work itself was quickly begun. In 1955 the modernization of Buildings 25 (the Breech Building), 35 (Medium Cannon Shop) and 125 (the Liner Shop) were undertaken and when the substantial improvements were completed two years later, the total cost amounted to approximately $3,000,000. In 1955 also, work started on modernization of the steam distribution system, which included an addition to the existing boiler house, Building 136. Two new boilers, each with a capacity of 100,000 pounds of steam per hour, were installed to supplement the existing two 50,000-pound boilers. This permitted removal of the old coal-

fired boilers in Building 124 and gave the Arsenal modern automatic oil-fired boilers in Building 136. The cost of this work ran to $2,000,000 and was completed the same year as the builidng modernization.

The rehabilitation of the manufacturing buildings, along with the replacement and modernization of machine tools, was a large step towards the goal of modern, efficient, flexible pilot line facilities capable of quick shifts from one type of work to another. The work on the steam system improved many of those facilities which had been installed during World War II, when shortages made necessary the use of materials that were less than the best. The improvement of the system made possible drastic cuts in operating and maintenance costs in following years.

In August, 1955, Colonel Mathews announced that the trend of the Arsenal away from mass production of weapons and toward development of research, original design engineering and pilot production would receive new emphasis in the future. An important effect of this, the Colonel predicted, would be the stabilization of the Arsenal work force at approximately its then present level, about 2,600 persons.

The Commanding Officer hoped that the development of research and engineering facilities would free the Arsenal from the need to keep large production orders on hand. However, while he was more or less correct, as later years proved, the problems of RIF's had not yet ended.

The announcement of a 25 man layoff in November occasioned the start of a minor furor that was to continue for the next few months. The basic cause of the difficulty was the unfortunate but familiar formula of more-men-than-work equals RIF. The Arsenal Apprentice Association circulated a letter predicting direct cutbacks in the work force beginning in the following January, 1956. The letter urged workers to contact their congressmen and this move brought consider-

able results. At the height of the exchanges of notes, tours and visits, in January, at least three New York State U. S. Representatives, and both the State's U. S. Senators were involved in efforts to forestall a RIF which threatened to separate more than 900 persons by the fall of 1956. At one point even New York Governor Averill Harriman became involved in the controversy and accused President Eisenhower of discrimination against New York industry in considering the proposed cutback at the Arsenal.

It is difficult to evaluate the influence of the efforts of the Congresmen to forestall the RIF, but, int he event, it did not reach the proportions at one time expected. Two-hundred and twenty-seven persons were separated in late January but the remainder of the force was retained by the receipt of some timely orders, the rehabilitation and modernization activity then getting under way and a schedule of staggered one-week "furloughs" for some workers the following May.

The end of January, 1956, was also the time for a happier occasion. This was the formal opening of the new Gage Building, numbered Building 44, for the annual technical meeting of the Dimensional Standards and Metrology Division of the American Ordnance Association. More than 200 outstanding representatives of the gage industry in business and government attended the sessions in the new Arsenal structure. Those chosen to present technical papers at this important meeting included the Chief of the Arsenal gage operation, as the representative for the Army, and Air Force Col. John P. Stapp, who had made history with his rocket sled experiments. The final cost of the new builidng with its more modern facilities for storage of the 200,000 priceless final inspection gages, temperature and humidity controlled experimental laboratories and highly sophisticated equipment was $612,000. It was money well spent, in view of the Arsenal's nationwide role as supplier of all final inspection gages for cannon-mak-

ing and since the result was a gage facility as good as the best in industry.

However, the building also became the headquarters of a newly-formed larger organization of which the gage operation was only a part. The National Industrial Division, formed the year before, was a unique feature of the Arsenal organization in that it was "in the Arsenal but not of it." That is, this group of specialists was so constituted that it could function anywhere in the nation but was located at Watervliet as the source of the skilled personnel and facilities.

The NID had several most important functions. It was charged with the responsibility for national procurement of all heavy conventional weapons, mobilization planning, and preparedness and maintenance of all pilot lines in layaway in private industrial plants. In its role as national heavy weapons procurer, NID received all orders for the heavy weapons in its sphere directly from higher authorities. It then opened these orders for bid on a competitive basis.

Watervliet Arsenal never entered into formal competition with private industrial establishments for these orders. Its manner of receiving work from the NID was to make an estimate (not an actual bid) of the price of the work if done at the Arsenal. This was then compared to the price of similar work previously done by private concerns. If the result was favorable to the Arsenal, and in keeping with its role as a limited producer, the work was awarded accordingly. However, it sometimes happened that certain work had, perforce, to be assigned to the Arsenal, since no one else had the skill or facilities to do it. When this occurred, every effort was made to keep down the Arsenal's price.

In regard to mobilization, it was necessary to be constantly aware of what facilities were available for production of weapons in event of an emergency, and how quickly they could be mobilized; to keep mobilization plans current and correlated with the latest developments

of design, material and manufacturing methods, gage and tooling requirements. These considerations had also to be observed in regard to the weapons production lines maintained in layaway in private plants.

In short, it was the function of the National Industrial Division to see that the unfortunate experience of the early years of the Korean War should not be repeated. Control of the Arsenal's readiness to play its part in any future mobilization was entrusted to the mobilization group of the Planning and Estimating Department, which was organized at this time. It was the function of this group, then and afterwards, to prepare, review and make layouts of mobilization components to the latest method of manufacture, as well as obtaining the tooling involved. Layouts and machinery were planned for the various major component lines, which were to function concurrently with all other jobs in the shops.

The modernization program continued through 1956 in the work begun the year before and receipt of an additional $1,660,000 for Fiscal Year 1956 permitted the completion of these projects and the acquisition of plans and specifications for the modernization of the heat-treating facilities in Buildings 14, 20, and 110. The new financial system continued its expansion throughout 1956 with efforts also devoted to the design and implementation of a dual-type standard cost accounting system as an adjunct to the new Industrial Fund financial operations. Watervliet was a pioneer among Army industrial installations in its work on this accounting system and the reputation of the Arsenal financial group extended beyond Army organizations and attracted visitors from abroad. Among these were Mr. C. H. Latchford, director of ordnance factories of the British Minsistry of Supply and two aides who came to the Arsenal to observe its financial operations at first hand.

The experience of having experts from allied na-

tions come to study Arsenal operations was not, however, unique. A delegation of Portuguese officers had made a study of the Arsenal a few years before and in early 1957 both the Norwegian Chief of Ordnance and a ranking Spanish ordnance officer made visits to the Arsenal. Yet, the exchange of defense information was a two-way street and the Arsenal also took advantage of opportunities to study foreign developments. Typical of the Arsenal's side of this exchange program were the visits of two Arsenal scientists to European nations in early 1957. In the first case, an Arsenal metallurgist was one of four United States representatives chosen to attend an international metallurgical conference in London and make a tour of British arsenals. The second major visit was made by a leading Arsenal engineer to Continental NATO countries to confer on defense needs.

The next step in the Arsenal modernization was the construction in 1957 of three small masonry buildings to provide safe storage areas for inert and flammable gases and acids. Designated Buildings 137, 138, and 139, they were erected at a total cost of $60,000. Also approved was expenditure of $301,000 for rehabilitation of machine tools. The tooling improvement program, together with improvement of plant layouts, continued for many months.

But the most significant addition to the Arsenal's equipmetn at this time occurred in June, 1957, with the acquisition by the gage group of a huge precision thread grinder. The machine solved a long standing problem in the manufacture of heavy weapons and six years later was still the only one of its kind in existence. During World War II and the Korean War, the Arsenal had encountered many difficulties in the procurement of large thread location gages necessary for guaranteeing the interchangeability of gun tubes and breech rings. The difficulty arose because of industry's lack of precision grinding equipment able to

hold large diameter threads to the close tolerances required and its reluctance to underwrite the development of a machine peculiar to the limited needs of the Arsenal. To solve the problem, the government underwrote the project and a $286,000 contract was awarded to Jones and Lamson Co. of Springfield, Vermont, in 1954. When finished and installed in the new Gage Building, the machine was capable of grinding threads to 30 inches in diameter, externally and internally, and up to five feet long externally, while holding accuracy to ten-thousandths of an inch.

The acquisition of the large precision thread grinder was followed a few months later by another vital step in the improvement of the Arsenal's gaging devices. This was the standardization of the boroscopes, the long, telescope-like optical instruments for visual inspection of cannon bores. Through a four-year program of study and development, two standard boroscopes were designed to replace the 13 different instruments formerly used. The M1 boroscope was designed for use with all the smaller guns from 20 mm. up and the M2 was made for the larger guns up to 280 mm. Beside the much greater facility of operation and repair, the new devices were far more economical than the older units. The M1 was only one-fifth as expensive as the instrument it replaced, and the M2 was less than one-third as costly as its older counterpart. Both were adaptable for use with a 35 mm. camera, which allowed either inspection by mail or simply study of a bore picture at leisure.

A $6,358,000 order for manufacture of 590 tank bulldozer blades, awarded the Arsenal in spring, 1957, promised some prosperity for the year. The unusual support order from Ordnance Tank Automotive Command was handled by a special unit organized the year before to plan such non-mission items. This group continued active in the following years as the Arsenal secured more non-mission orders and became

more involved in the use of exotic materials and advanced machine tools. Illustrative of the difficult materials and equipment being worked on was the chrome-plating operation. While chrome plating of the interiors of the gun tubes had been a regular process for some time, a major amount of effort was now being directed to plating of the gun exteriors.

All experimentation, design and development for this process was carried out at the Arsenal. The experimentation to derive better methods of plating bore interiors continued, however, and an Arsenal engineer was awarded a patent for a new plating anode and process which made it possible for an unskilled person to plate bores up to 24 feet long on a production basis. The time involved was cut from 40 hours to four hours per gun.

In November, 1957, cuts in defense spending again made a reduction in force necessary at the Arsenal. The RIF affected 93 semi-skilled employees in the manufacturing and service units and brought the total Arsenal work force down to about 2,450 persons. This reduction was unattended by any of the congressional inquiry which had accompanied the previous ones, even though Colonel Mathews announced that, unless more work was found, an additional 100 persons would have to be separated the next spring. The Commanding Officer, however, was optimistic that more work could be found. Events proved him right and the further layoff did not take place. A good deal of effort was made to find the 93 people new positions. Advertisements, which were placed in local newspapers by the Arsenal Civilian Welfare Council, listed the skills of the separated Arsenal workers and the Commanding Officer offered his personal assistance.

The year 1957 was not all filled with bad news for the Arsenal employees, however, since two new recreational activities were begun in addition to the baseball, basketball, bowling, tennis and

other programs which continued from former years. These were a nine-hole "pitch and putt" golf course and a flying club. The golf course was laid out over the lawn and tree areas in the eastern part of the Arsenal. The Arsenal Flying Club was equippped with two Army Piper Super Cub and one Ryan Navion light airplanes. The aircraft were not in use by the Army at the time and all maintenance and operation costs were borne by the club members. Both activities proved a lasting success with the Arsenal employees and military personnel.

In February, 1958, the Arsenal employment level remained 2,450 and of these the 1,800 employees paid on an hourly basis received a wage increase of about 6%, as had been the almost yearly practice for several years following Army-Air Force Wage Board surveys of area industrial pay levels.

The 650 Arsenal employees with classified Civil Service positions received a 10% pay raise four months later, their first pay increase in three years. The increases in pay for each of the segments of the Arsenal work force brought the total annual payroll at this time to well over $12,000,000.

In the late spring a new and advanced method of producing holes in metal was introduced into gun-making operations at the Arsenal. The method was trepanning, wherein a solid core was cut from the metal work piece instead of chips, as in the standard boring methods. Also, the work was held stationary and the cutter rotated, thus making it much easier to cut holes in pieces which would be awkward or impossible to rotate for boring. The device, as applied to the Arsenal's work, had other valuable advantages such as greater economy, speed, versatility and accuracy.

Colonel Mathews expressed his optimism in regard to the Arsenal's activity in the near future and hoped that the workers separated in the last RIF could be hired back by the end of the year. His optimism was apparently well-founded, since in the

next few months of spring, the Arsenal received substantial orders for 90 mm. tank guns and 90 mm. guns for the M56 Scorpion self-propelled weapon. These caused no expansion but made it possible to maintain the work force at approximately 2,450 for several months thereafter. There was other good news too in the spring of 1958, when the Arsenal's small business program drew the attention and commendation of officials of the Office, Chief of Ordnance. These officials urged the adoption of the Arsenal's system of utilizing small business firms as components producers at all 70 of the Ordnance Corps' arsenals, depots and district offices. The point of the small business program was to provide an equitable opportunity for the smaller private manufacturers to participate in filling the Arsenal's procurement needs.

A keystone in the Arsenal's successful development of the program was the "small business seminar," in which representatives of the smaller companies gathered at the Arsenal for a time to study those parts of Arsenal operations where they might be most useful and to learn the rules of government purchasing and contracting practices applicable to them. The success of the Arsenal's small business procedures was well reflected in procurement figures for the period July, 1954-December, 1957. During these three and one half years 87% of the contracts awarded and $8,342,400 or 68% of the total dollars spent on open market purchases, went to small business firms.

The following month, May, Colonel Mathews announced his retirement from the Army after 30 years' service. During Colonel Mathews' four years as commander of the arsenal, significant advances had been made in management, manufacturing processes, stabilization of the employment level and conversion of Arsenal operations from a semi-mobilized to a peacetime basis. Following his retirement, Colonel Mathews took an

executive position with a private manufacturer of gage instruments and machine tools. Lt. Col. A.B.C. Nicholls served as acting commanding officer of the arsenal in the weeks between the retirement of Colonel Mathews and the arrival of the new commanding officer.

The continuing effort towars complete modernization of the Arsenal's buildings and equipment received a large and welcome boost in July, 1958, with the announcement of allocation to the Arsenal of $4,964,000 for major projects. Three-and-one-half million dollars of the money was scheduled for the major and necessary overhaul of the entire Arsenal electrical system. The remaining $1,464,000 was used in a large program for replacement of capital equipment, chiefly new machine tools, equipment installation and plant layout. But if the Arsenal was spending millions of dollars, one could be sure that they were being spent wisely. Proof of this arose only the next month when, at the completion of the tank bulldozer blade order, the Arsenal was able to announce that it had finished the job for $750,000 less than the original estimate of more than $6,000,000. Careful purchasing of the electric and hydraulic components by Arsenal experts made it possible to return the large saving to Ordnance Tank Automotive Command. A further dividend accruing from this order was the fact that 24 arsenal machine operators were trained as welders to aid in its completion and thus gained another skill for themselves and broadened the Arsenal's reservoir of trained men.

Yet the most important event of August, 1958, for Arsenal people was the arrival of Colonel Walter M. Tisdale, the new Commanding Officer. Colonel Tisdale had served with the Army in Europe for several years as Ordnance Officer for the Seventh Army and, for the period immediately before assignment to the Arsenal, he was deputy ordnance officer for the U. S. Army in Europe. A native of New York State,

CLASSROOM — Arsenal managers discuss value analysis in a classroom setting in September 1955.

the Colonel's long and varied career had begun in the 174th Infantry Regiment, New York National Guard, from which he entered the United States Military Academy in 1928 via a National Guard competitive examination. Commissioned in the Artillery, he served with that branch until World War II, when he transferred to Ordnance. A pioneer in aviation ordnance, the colonel served with the Army Air Corps throughout the Pacific campaigns and held several important posts in the Ordnance Corps in the years following, including command of Philadelphia Ordnance District for the three years before his assignment to Europe. In mid-September, 1958, 35 leading Army and Navy industrial experts gathered at the Arsenal to take part in a "value analysis seminar." Value analysis, a method of systematic application of modern cost reduction techniques to particular items, was a newcomer to the Arsenal. Although value analysis was begun in industry and first tried by the government in a Navy organization in 1954, Watervliet Arsenal was, in

1956, the first Army installation to organize a value analysis unit. The chief Arsenal managers were introduced to the system in December, 1957, and the first value analysis seminar conducted by the Arsenal unit was held the following March for 24 leading members of the Arsenal staff. In June, 1958, a presentation on value analysis was made for officials of the Office, Chief of Ordnance in Washington, with important results.

Shortly after the presentation, General Hinrichs, Chief of Ordnance, wrote to Watervliet that "value analysis as organized at your arsenal has a corps-wide application. Accordingly, I have directed that all commanders of commands and arsenals be given this presentation." It was this favorable impression on the chief of ordnance by the Arsenal team which brought the representatives of the Ordnance installations to the Arsenal in September and launched the value analysis program throughout Ordnance under Arsenal direction.

At the presentation of certificates of completion at the

VALUE —The arsenal's value engineering display is among other exhibits of the U. S. Army Weapons Command in 1964.

end of the two-week course, Colonel Tisdale explained that the 12 seminar projects had resulted in potential savings of more than $1,750,000. These ranged from potential cost reductions of $803,000 for nozzles for the Jupiter missile to $52,000 for vehicle instrument lighting components.

As 1958 moved toward a close there were still about 2,450 people on the Arsenal payroll and Colonel Tisdale announced a plan to submit proposals to the Office, Chief of Ordnance after the start of the new year for a large expansion program for the Arsenal. The colonel proposed that Watervliet Arsenal be given the complete missions for recoilless rifles, mounts, carriages, and recoil mechanisms in addition to its current gun mission. But, most important, was the Colonel's plan that heavy emphasis be placed on research, development and engineering. It was the Arsenal commander's hope that the Arsenal could be made into a completely modern pilot facility so that the complete weapon could be shown to the private manufacturer and the installation would be capable of complete crash production in the event of another emergency. Colonel Tisdale predicted that while the Arsenal might not get everything it asked for, there was enough interest to promise a favorable outcome, the effects of which might be felt over a period of years. The Colonel's forecast was to prove correct in ensuing years.

The year 1959 began well for the Arsenal in its continuing effort to place increased emphasis on improvement of operations and research and development. Two items with familiar household names, ceramics and aluminum foil, were introduced in January to aid in one of the most difficult Arsenal manufacturing operations. However, the ceramic tooling, designed by Arsenal engineers, was related to the ash tray variety in name only. These ceramic cutters were used in the turning operation of 120 mm. tank guns to pare away the excess of the superhard

steel. The aluminum foil provided a cushion for the cutting tool which permitted it to compensate for irregularities in the surface of the metal being cut.

The ceramic tools were capable of a much longer life than the best carbide tools in use and had the additional important feature of passing the heat of cutting to the chips, rather than the gun tube. Thus, the gun tube did not expand during the turning operation, necessitating that the operator continually make corrections for the expansion; one adjustment was sufficient for the whole turning cycle. This was a decided improvement that would prove itself over and over again.

The efforts to place more emphasis on the research and engineering work at the Arsenal were slowed by the difficulty in recruiting qualified personnel.

In February, the shortage of scientists and engineers was termed "critical" and intensive efforts were made toward recruitment of metallurgists, mechanical engineers and physicists with graduate degrees.

The salaries offered, though always lower than those obtainable in industry, were attractive: $6,000 to $14,000 per year.

In addition, the Arsenal offered the considerable benefits of working in a Civil Service organization and last, but surely not least, the opportunity for public service. However, the general scarcity of such people throughout the nation and the sharp competition for their services, made possible only a gradual strengthening of this phase of the Arsenal's activity. Yet, if the expansion of the research and engineering was not as great as desired, there was no doubt about the ability of those already active in the field at the Arsenal, as was proven by the selection of the Arsenal as the site for a vehicle weapons conference in February, 1959, which was attended by 40 representatives of Department of the Army, Continental Army Command, Ordnance Corps, Marine Corps, and the Armed Services of Canada and Great Britain.

Fourteen Arsenal apprentices became journeyman machinists at the end of February after graduation from the Arsenal Apprentice School. Their graduation at this time was a mark of health in this important activity which was now proceeding steadily, completely recovered from the post-war difficulties of several years before. At this time there were 70 apprentice machinists and 21 apprentice draftsmen in training. The program was calculated to have provided a total of 404 machinists since its inception in 1905.

In April 1959, work began on the major $3,000,000 project of overhauling the entire Arsenal exterior electrical system. This project, for which the contracts had been let the previous October, was made vitally necessary because of the fact that at this time the amount of electrical power being used, at a reduced peacetime level of activity, exceeded the power requirements of World War II and was equalling the maximum capacity of the system.

Included in the project, besides elimination of some interior electrical deficiencies, were a new transformer substation, 25 small unit stations, underground installation of all power, lighting and communications system lines and consequent removal of all overhead lines and utility poles. The improvements to the electrical system were also designed to provide cheaper power.

The Arsenal scored one success that spring which was almost more than it could handle. Attendance at the annual Armed Forces Day at the Arsenal had averaged a manageable 15,000-20,000 since 1955, when efforts were begun to attract a larger number of visitors than formerly. In May, 1959, however, an overwhelming 33,374 people visited the Arsenal grounds between 10:00 a.m. and 4:00 p.m.

The main attraction was a scaled-down parachute training device called the "Junior Jump Tower," which was operated by soldiers of the 101st Airborne Division. The jump tower consisted of

a platform about 10 feet high with a cable running to a ground level point 120 feet away. Children climbed the tower, were strapped into a scaled-down parachute harness, the harness was then hooked to the cable and the child went zipping off into space to come to a not too gentle halt at the other end of the cable. The advertisement of this and other displays by an area radio station throughout the day did much to bring the record crowd. The attendees also included a party of area Congressman, mayors, college and university officials, industrial executives and newspaper publishers. And for the majority, the Open House provided a first opportunity to see at first hand the Arsenal and the weapons the Arsenal, the Army, and the other services were preparing to maintain the national defense.

That spring also, the Arsenal participated in a parade and ceremonies marking the City of Watervliet's observance of the "Year of History," part of the New York Hudson-Champlain Celebration which commemorated the exploration of the region 350 years before. A float entered by the Arsenal in the memorial parade won second prize.

The summer passed well for the Arsenal and was marked by the introduction of a very successful machining process known as rapid threading; beginning of work on a swimming pool, and attendance at a NATO steel conference in Rome, Italy, by an Arsenal scientist.

Rapid threading, using carbide cutting tools, proved quicker than grinding or hobbing and provided better finishes for the threads needed on gun tubes at the muzzle and breech ends. Also the machine used required less floor space and was capable of automatic operations.

The commencement of construction of a 32-by-50 foot swimming pool in the open recreational area in the northeast section of the Arsenal occasioned something of a stir in the local press. Charges were made of discrimination against the civilian employees since the pool

was to be primarily for military use. However, the $24,158 cost of the pool was drawn from Army funds appropriated for maintenance of morale among military personnel and although some of the Arsenal's higher graded civilians were permitted to use it, it was intended to serve the approximately 250 officers and enlisted men, of all services, on duty in the area, not only those at the Arsenal. To open such a limited facility to the thousands of employees would have created an impossible situation, as Colonel Tisdale pointed out. In any event, the problem proved short-lived.

In October, employment still remained constant at about 2,450 persons, who were expected to earn a very respectable $13,523,679 in salary and wages for the year. Colonel Tisdale, in an address to the Arsenal Foremen's Association, forecasted a "steady and confident" future for the Arsenal. The Colonel cited the need for continued diversification in support missions in order to offset lulls in the protype production of the Arsenal's main mission items. Examples of such work the Arsenal was performing at this time were programs for the rehabilitation of helicopter and liaison aircraft motors for Army Transportation Corps and some work for the Army Signal Corps. However, orders for 8-inch howitzers and 90 mm. tank weapons were received at this time and the workload of the Arsenal's main items was fairly constant, the Colonel said. Colonel Tisdale also noted that there had been a slight increase in funds which would permit increased research and engineering activity in the near future.

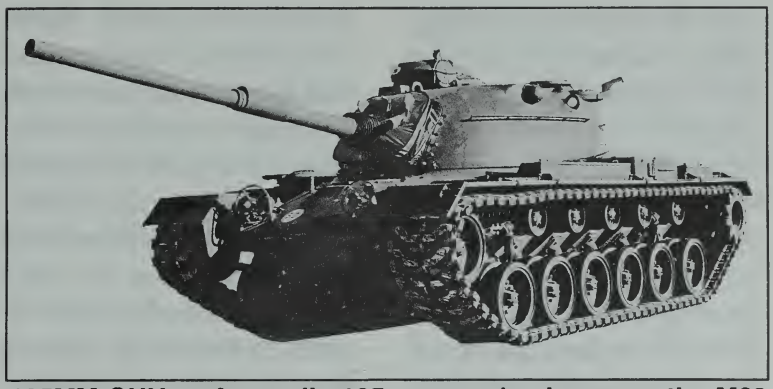
The stress on the development of the "R&E" activities at the Arsenal since Colonel Tisdale took command was beginning to bear fruit and only the next month Brigadier General C. W. Clark, Chief of Research and Development activities in the Office, Chief of Ordnance, found the Arsenal's increased potential in basic research during the previous year "a particularly impressive

achievement." General Clark, present at the Arsenal on an inspection tour, also predicted "a long and active future for conventional weapons of the type designed and produced at Watervliet Arsenal." The General's statement once more emphasized that the thinking concerning the composition of the national armament had come full circle since the days some years before when the new and awesome power of the atomic bomb had made it seem that conventional weapons had become obsolete. Korea and the tensions of the years of Cold War which followed demonstrated the crucial need for modern, superior conventional arms.

Some months before General Clark's visit a large step had been made to facilitate the development of these weapons at the Arsenal through reorganization of the Arsenal's research and engineering units. The purpose was to centralize these functions and provide for expanded research facilities. The new Research and Engineering Division, when formed, contained the elements of the previous Research and Development Division, plus the engineering segments of the National Industrial Division and the Operations Division. In all, the new division was broken into three main segments: Research Branch, Design Engineering Branch and the Industrial Engineering Branch.

The variety of the work the Arsenal engineers were engaged in was demonstrated in October, 1959, when the new 90 mm., M67, Recoilless Rifle was accepted by the Army for troop use and again a few months later when the Arsenal began shipment of the new 105 mm., M68, Tank Guns.

While the basic research and engineering on the 90 mm., M67, was done at Frankford Arsenal, Watervliet was charged with manufacture of the prototype weapons, testing, industrial engineering and pilot line production. The rifle was a considerable achievement since it was only four feet long, weighed only 35 pounds, could be fired by



105MM GUN — Arsenal's 105mm gun is shown on the M60 main battle tank in the mid-1960s.

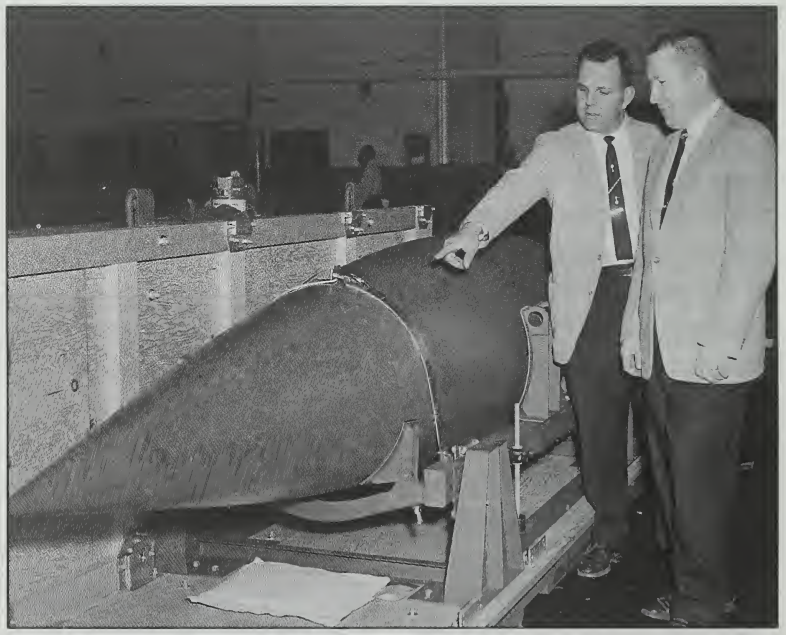
only one man and yet could hurl a nine-pound 90 mm., shell 500 yards with the power of a medium tank gun. The testing of the weapon had taken an Arsenal engineer to Fort Churchill, Manitoba, Canada, in January to observe its performance under the most rigorous winter conditions and again in August to the searing heat of Yuma, Arizona, to put it through its paces under desert conditions. The testing resulted in some modifications to the original design of the breech mechanism before acceptance and production.

The 105 mm., tank weapon represented the most advanced gun of this type and was designed to arm the much improved M60 main battle tank. Its capabilities were an impressive combination of high accuracy, rate of fire and armor piercing power with automatic loading, sighting and firing.

Yet, probably the most illuminating statement on the Arsenal's intensification of research and engineering programs was made by Colonel Tisdale himself in a newspaper interview early in the next year. He noted the employment by the Arsenal of an increasing number of highly sophisticated scientific devices, such as the electron microscope, the gauging equipment already mentioned and the impact tester for breech rings, which simu-

lated the pressures of firing; but most important was the gathering of a body of highly educated and skilled scientists and engineers. "What has happened here this past year," he said, "is really an expansion of research, rather than a complete switch. Some research was going on before but it limited to cannon manufacture. Some of the work now being done in materials has applications in other weapons fields, and of course to science in general. While we continue to make guns here we think of this arsenal no longer as a production facility. We are not competing with private industry. Whereas previously we were content merely to keep abreast of developments in research and design, we are now jumping way out ahead by becoming a research and engineering center.

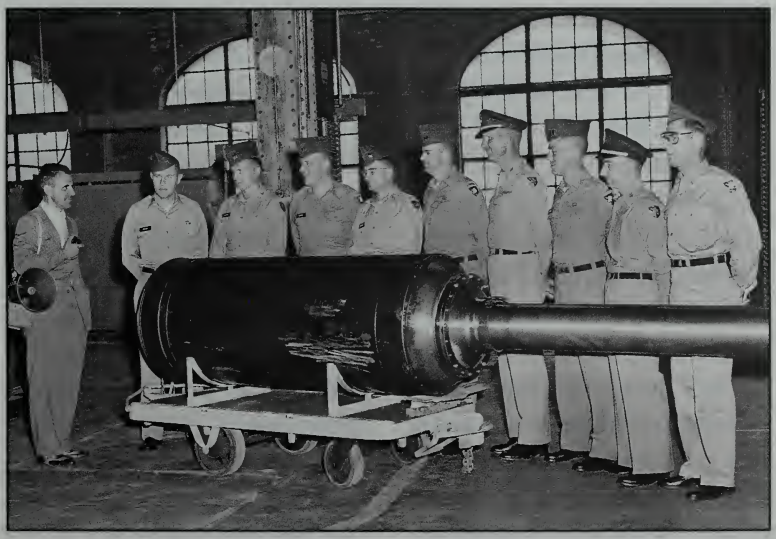
"Notwithstanding the increased emphasis on the sci-



NON-MISSION — Redesigned warhead of Honest John missile was among non-mission items produced in 1960s.

entists, Watervliet Arsenal has not denied its heritage of practical experience, gained over the years, which has stood it in such good stead in winning our wars. Older, more experienced hands and heads are contributing their invaluable knowledge to balance the organization. Their contributions have been and will continue to be indispensable."

January, 1960, brought another breakthrough in manufacturing methods to enable the Arsenal to be better able to meet its traditional responsibility for cannon and, what was the cause of considerable rejoicing after much anticipation, the Arsenal's first large assignment in missile weaponry. The manufacturing success was the carbide boring bar. The bar, three times more rigid than the hardest steel, was born of the difficulty of boring the powder chambers of 120 mm. tank guns with the necessary high degree of accuracy and finish. The bar was more than five feet long and weighed 500 pounds. It was the largest such bar made of



MISSILE MOTOR — Nike-Hercules missile sustainer motor is described to group of visitors from West Point.

the difficult-to-work material up to that time. The use of the bar more than halved the machining time of older methods of boring powder chambers and eliminated tool maintenance costs entirely. The realization of the advantages of this equipment led to acquisition of similar bars for producing powder chambers in 90 mm. guns and 8-inch howitzers.

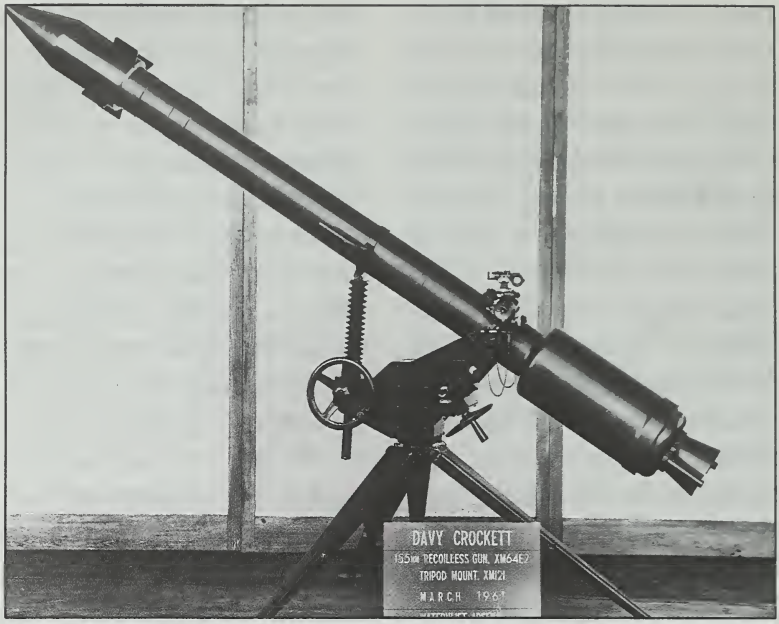
The Arsenal had hoped to receive missile assignments for several years in order to broaden the base of its support activities and thus ensure a relatively steady level of operations. Attempts to secure such work had been made at the time of the post-Korea RIF's but they had been without success. An indication that the Arsenal might have a chance of entering the missile field was given in remarks by General J. E. Engler, a procurement specialist, before a House Appropriations Committee hearing on armed services procurement, a year before. The general had urged the Congressmen to "modernize Watervliet Arsenal and maintain it on a completely up-to-date basis so that we can phase into the newer items of production and maintain the technical competence for this particular type of work [missiles]." Subsequently the Arsenal received some secondary assignments on minor Hawk missile components and in December, 1959, received an assignment from the Army Guided Missile Agency at Redstone Arsenal, Alabama, to re-design and fabricate structural and framing members in the warhead compartments of advanced Honest John missile prototypes in order to ready the system for production. The orders received in January, 1960, however, were for sustainer motors — major components — for the Army's Nike-Hercules anti-aircraft defense missile. The sustainer motors, as the name implies, were designed to propel the missile in flight after initial blast off. The weapon system, complete, was 39 feet long, atom armed and designed to electronically select as a target either a single aircraft or an entire forma-

tion. It was launched by a solid propellant booster. The receipt of the missile motor order occasioned no large increase in the Arsenal work force but did make it necessary to acquire some special skills and equipment. The south end of the Big Gun Shop, (Building 110), was converted to a missile area to handle the Nike-Hercules production. At a cost of approximately $60,000, it involved some excavation, paving and miscellaneous steel work.

Following the receipt of the missile work in January were two "bread and butter orders" in the Arsenal's main field of effort — guns. These were for the new 105 mm. M68 tank weapons and, although for relatively small numbers of weapons, in accordance with the Arsenal's limited production policy, they were sufficient to maintain a steady work load for several months to come.

In mid-April, 1960, scientists representing Rock Island and Picatinny Arsenals and several national metal producing companies gathered at the Arsenal to discuss the application of titanium, a new high strength, lightweight metal to modern weapon manufacture and particularly the advantages it might offer in fabrication of a new weapon system — the "Davy Crockett." Although that famous frontiersman was justly famed for his skill with the long rifle, it is certain that he could never have envisaged such a weapon as that which was to bear his name many decades after his passing.

The Davy Crockett system consisted of a jeep- or tripod-mounted recoilless launcher which could fire an atomic warhead of considerable force but with an effective area small enough to avoid damage to the user, friendly forces or civilians. With its very high degree of mobility, it gave the front line infantry troops a low-yield nuclear punch of a strength that had previously been available only from heavy artillery. Adaptability to conventional warheads also increased the effectiveness of the weapon. The



DAVY CROCKETT — The Davy Crockett, a 155mm recoilless gun, XM64E2, is shown on a tripod mount.

Davy Crockett system was displayed publicly for the first time at a demonstration of modern weapons at Fort Benning, Georgia, in May, 1960, where a distinguished onlooker, President Dwight D. Eisenhower, there on an impromptu visit, was much impressed with it possibilities.

Watervliet Arsenal had been a part of the Davy Crockett development effort since early 1958. In the final stages of the weapon's development the Arsenal was assigned the task of refining the original design for manufacture and fabrication of the prototype launchers and tripod mounts. Following the completion of this phase, Watervliet assumed national production and procurement control of the system.

The attendance at the Arsenal Armed Forces Day Open House at the end of May was somewhat less than the record attendance of the year before but still attained

the highly successful figure of 21,643 persons. The visitors explored the Arsenal grounds and viewed a parade and the exhibits with the usual keen interest but as an area newspaper editorial writer observed after the close of the event, the displays of gleaming weapons of national defense had a new meaning that spring in the wake of the sabotage of the Paris Summit Conference by the Soviet Union.

In mid-summer of 1960, the Arsenal received a signal honor for its efforts in the field of industrial safety. This was the National Safety Council Award of Honor for 3,007,568 consecutive man-hours of work without a disabling injury. The period during which the award was earned extended from December 8, 1959, to July 25, 1960. Watervliet Arsenal was the only arsenal to receive the award and only the third Ordnance Corps installation to be so honored. The plaque which Representative Leo W. O'Brien of Albany presented to Colonel Tisdale on this occasion was not, however, the result of a luckily accident free six months; rather it was the culmination of years of intensive effort by the Arsenal safety specialists and administration. The Arsenal's rate of disabling injuries for each million man-hours of work during 1960 was the lowest in its history. The accident figures for the previous decade manifest the success of the Arsenal's safety program: 1951-10.2; 1952-6.3; 1953-6.4; 1954-6.4; 1955-4.3; 1956-2.8; 1957-2.0; 1958-1.4; 1959-1.7; and for 1960-0.8.

A large contributing factor to the successive reductions in the accident rate at the Arsenal were the programs of foot and eye protection. The foot protection program was instituted at the Arsenal in 1950, when the wearing of safety shoes was made mandatory for all employees in shop areas, even though the cost of the shoes was, and continued to be, borne by the employees. Through this emphasis, the Arsenal became one of a relatively few industrial plants, civilian or military, to have a

100% foot protection program. The development of eye protection was begun the year after institution of the foot program and made safety glasses, plain or prescription, mandatory in shop areas for anyone working in or entering these areas. Under this program the Arsenal bore the cost of all safety glasses and other eye protectors such as shields and goggles. It was arranged so that employees who spent more than a casual amount of their working time in the shops could be issued prescription glasses, one pair each year if necessary, and could retain them for a nominal fee if their Arsenal employment was terminated.

The Arsenal's achievements in the field of safety were permanently recorded when a congratulatory letter from the president of Associated Industries of New York State Inc., describing the Arsenal safety program, was read into the Congressional Record by Representative Leo W. O'Brien of Albany.

Efforts in the development of research and engineering continued paramount through 1960 and the Arsenal programs received unique praise in August during the visits of Dr. George H. Lee, then chief scientist for the Office, Chief of Ordnance, and Assistant Secretary of the Army Courtney Johnson. Dr. Lee forecast that the wars of the future would be fought with light, powerful weapons "imagined, designed and manufactured [in prototype and pilot line]" at Watervliet Arsenal. He praised the Arsenal's advances in cold-working, by which its modern weapons were made 40% lighter than those of the World War II era. "The Arsenal's facilities are most unusual," Dr. Lee stated. "Work can be done at Watervliet that can be done nowhere else. The powerful weapon of the future is a different weapon, a Watervliet Arsenal type weapon. I have been deeply impressed by the research which has been carried on here which has resulted in major improvements to conventional weapons. I have found here the initiating of ideas, novel concepts and a terrific spirit of cooperation

with other Arsenals and Ordnance Corps installations. ...This research is not limited by the interests of the Ordnance Corps. It is of the utmost importance to the entire nation.... In the past there was a tendency to get an idea and get immediately into production. Now at the Arsenal the research men get an idea and develop it fully.

Then when the time is right, they get the idea into production. Then the mistakes don't show up in the field as they did in World War II. This is healthy and economical." Secretary Johnson also did not find the Arsenal wanting. He stated at a press conference at the Arsenal that the installation was of "absolutely first importance to the Army."

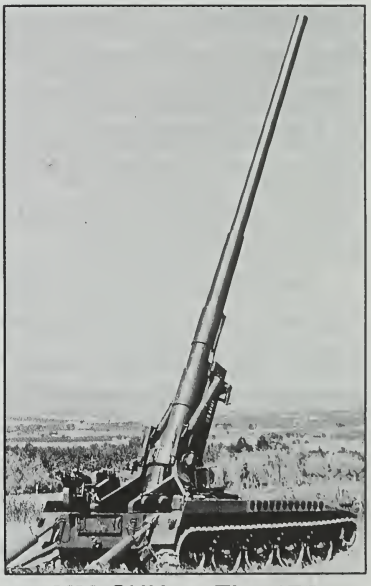
Lending substance to the flattering remarks of the two high defense officials was the completion at the end of November, 1960, of a new group of laboratories and the scheduling of others. The expanded laboratory facilities were designed to increase the Arsenal's ability to investigate the properties of metals; to seek new and improved coatings for gun tubes, and to study non-destructive testing techniques for all the U.S. arsenals and Ordnance Corps installations. The laboratories completed at this time were, respectively, for the study of materials, electrodeposition and vacuum deposition. Those planned for completion in the following six months would deal with photoelasticity, radiation and solid state physics. The Arsenal's continued recruiting advertisements during these months for men with graduate degrees in physics, chemistry, metallurgy, mechanics, mathematics and mechanical engineering accented the importance of these developments.

A year-end look at Arsenal operations in preceding months showed that employment had remained constant at 2,450 persons. The payroll, however, due to periodic raises to keep the Arsenal workers' pay in conformity with area employees of private industry, had topped $15,000,000. It was noted that "the primary national

mission responsibility of Watervliet at year's end continues to be the development, procurement, production, industrial engineering and industrial mobilization of cannon, mortars, recoilless rifles, guns and howitzers from 37 mm up."

The new year opened auspiciously as a personal representative of Watervliet Arsenal took a prominent part in the inaugural parade of the new President, John F. Kennedy, in January, 1961. The Arsenal representative was the new 175 mm self-propelled gun, almost entirely a Watervliet product. The new gun, later designated M113, embodied many of the features most sought after in modern ordnance. It weighed only 26.5 tons and was designed to be interchangeable in the same vehicle with the 8-inch howitzer and 155 mm gun. Moreover, it was air transportable and capable of 20-mile range. The long range and high speed of the vehicle built to carry it, made it a formidable weapon indeed. Colonel Tisdale called the gun the product of the "union of an unequalled knowledge of weapons design with the skill and knowledge of the world's best arms craftsmen."

The Arsenal was awarded a large order for the new guns and the new model 8-inch howitzer that spring, which ensured a steady work load and brought improvements in both manufacturing processes and facilities. The manufacturing process improved was in the chrome plating area. The 40-foot length of the 175 mm. gun



175MM GUN — The 175mm gun, T256, on the self-propelled vehicle, T235.

tube made it impractical, from the financial point of view, to use a moving anode to chrome plate the bore. Arsenal engineers began study of the problem and reached a solution in fabrication of an anode as long as the gun itself. Further improvements were effected through use of the gun tube itself as the container for the plating solution, thus eliminating the necessity of immersing the huge tube in a plating tank. The length, weight and diameter of the anode when completed were unique, as were the 30,000 amperes of electricity needed to operate it and the 60-ton refrigeration unit needed to keep the whole apparatus at the proper temperature during the plating process.

The cost of the new plating facilities and other equipment for pilot line manufacture of the 175 mm. gun was included in a more than $2,750,000 grant received in 1961 for acquisition of new machine tools and rehabilitation of older equipment. The continued overall improvement of the Arsenal's operating equipment was thus ensured.

The announcements of receipt at the Arsenal of new work orders had, for many months been accompanied by statements that the work would require no additions in force. However, a $2,000,000 order from Springfield Armory for industrial engineering and pilot production of rifle and machine gun components, received in February, 1961, was followed by an announcement that the Arsenal would add about 50 manufacturing personnel to the force. Small as the increase was, it was the harbinger of a new expansion, soon to take more definite form.

March, 1961, brought another manufacturing breakthrough with the automation of the rifling process, a most important phase of cannon making. The rifling process then in use was "ribbon rifling," itself an improvement on previous methods but one which still retained certain drawbacks.

The rifling "ribbon" was a steel bar 15-25 feet long which was set up to du-

plicate the twist of rifling when used as a cam. The machine attachments traveling over the bar determined the action of the rifling cutters inside the bore. The ribbon was used for the rifling operation on small quantities or to make a rifling bar for production items. The method was effective but the ribbon was large and unwieldy and an elaborate series of vises was necessary to hold it in place during the operation. This entire system was replaced by a 10-inch spool of magnetic recording tape and a small electric motor. The rifling instructions were electronically recorded on the tape by engineers and fed by the tape to the small motor which controlled the rifling head. The new method was quickly applied to rifling 105 mm. tank guns and proved much more accurate than the old. It saved 40 to 80 hours of the time necessary to set up equipment for rifling. The new method showed itself particularly adapted to experimental rifling projects and it greatly increased the Arsenal's potential production capability.

The centralization of the research and engineering facilities of the Arsenal planned some months before began to take physical shape in April, when the rehabilitation of Building 40 was begun to house design engineering groups and allied units. The rehabilitation of Building 115 also commenced to provide expanded facilities for the mechanical and physical testing laboratories. The area Veterans Administration offices, the only remaining one of the Arsenal's post-World War II "tenants," vacated their quarters in Building 40 three months later to make way for the expanding research facilities.

Arsenal operations moved ahead smoothly through the late spring and early summer. The Armed Forces Day open house this year, attended by more than 18,000 persons, was highlighted by presentation of special medallions to Colonel Tisdale and a descendant of Col. Elmer E. Ellsworth (the first United States Army

officer killed in the Civil War) by the New York State Civil War Centennial Commission. A contract awarded to the Arsenal in June for pilot line production of the new 90 mm., M67, Recoilless Rifle contributed to the installation's future security. The work force remained constant at 2,500 as the post went into its two-week summer shutdown in July.

In August, 1961, began a succession of happy events for the Arsenal that continued through the end of the year and ranged from accolades for the skill of its workers to some of the most unusual work it had ever undertaken.

The U.S. Navy, an old Arsenal customer, extended its thanks to the Arsenal for the assistance it had rendered in the Polaris missile program. This work involved the ultrasonic testing at the Arsenal of critical components of the missile; a job for which the Arsenal was equipped by the experience of similar testing in cannon research. Only a few days later the Arsenal's use of ceramic cutters in the rough and semi-finish turning of gun tubes came to the attention of a national metalworking trade publication. The editors noted that the Arsenal use of the material was "one of the first and most successful applications of the material of such tools." The new cutters were used on the 105 mm. gun (manufacture of which was attended by a number of process improvements) and made it possible to reduce the guns' production time, tool and labor costs by half.

The end of September brought a "bread and butter" order for manufacture of 105 mm. guns for the M60 tank and a major missile component assignment from the Navy. The missile assignment was for the manufacture of a significant number of sustainer motors for the Navy's Terrier missile, the principal air defense weapon of missile cruisers and destroyers. Colonel Tisdale pointed out when this order was received that the Arsenal's work on the Nike-Hercules system had been a "significant factor," in the

award of the job to the Arsenal. The Terrier was designed to intercept enemy aircraft beyond the range of the regular anti-aircraft guns of the ships and to protect landing zones during Marine amphibious operations.

The receipt of the Navy missile order was followed by a $1,000,000 further modernization and development of facilities in the Big Gun Shop to cope with the special requirements of the new program. Some of the huge lathes in the south end of the building were removed and excavations begun for the new missile making equipment. The main item of the new equipment was a new gantry furnace, a huge cylindrical heating apparatus mounted on rails over a 32-by-84-foot pit containing six underground quenching cylinders in a row. The whole furnace travelled on the rails from one cylinder to the other, controlled by one worker walking alongside. Preparation of the site, installation and testing of the equipment was a major project extending over a period of several months.

In October, the Arsenal began work on one of the most unusual projects it had ever handled: the "hypervelocity gun." Rather than being a "gun" in the common understanding of the term, however, this was to be a sophisticated cylindrical device that would achieve space age velocities at the muzzle end of its 98-foot length. The work was a joint Army-Navy project but the unusual design was the Navy's. The gun consisted of an 8-inch Navy gun bolted muzzle-to-muzzle to an 8-inch Army gun; the breech section of a huge 16-inch naval cannon, which served as the pressure chamber; the breech section of another 8-inch gun and finally a 155 mm. gun tube inside which a pair of 3-inch Navy guns were joined muzzle-to-muzzle. Probably the only comparably unique work the Arsenal had done was manufacture of the 40-inch bomb tester in 1948. The latter, possibly the largest single item the Arsenal ever made, grew out of the wartime discovery that

the casings of many aerial bombs fractured before explosion of the bomb charge, when they struck concrete structures. By use of the bomb tester, bombs could be propelled against concrete structures on a range under controlled conditions. The information thus gained was applied to development of better casings.

The gradual increase in the Arsenal's work force, which had begun some months previous, continued through latter 1961 and by mid-November the force had reached 2,700. Then, however, employment took a sharp jump upwards when the authorization to hire 250 more people was received. It was planned to add these people gradually over a four month period, to meet increased national defense requirements for the Arsenal's weapons. Some of these items, then in prototype or limited production at the Arsenal, were the 105 mm., 90 mm., and 175 mm. guns, the 90 mm. recoilless rifle and components for the Davy Crockett and Terrier systems.

Toward the end of November, the Arsenal's reputation for good work on difficult jobs brought an order from the Air Force for manufacture of 15 coupling kits for the EXOS IV space probe vehicle. These small but important units were used to link together the sections of the EXOS vehicle which consisted of an Honest John Rocket topped by an M5 Nike booster rocket, which in turn was surmounted by a Yardbird rocket. The three-stage solid fuel system was designed to obtain geophysical information, through probes of the ionoshpere, for use by the Air Force and National Aeronautics and Space Administration 'man-in-space' programs.

On December 1, 1961, Colonel Tisdale announced that he would retire from command of the Arsenal and the Army on January 31, 1962. Colonel Tisdale, however, entered in "retirement" a job that was probably almost as difficult as the one he retired from. He was appointed assistant to the president of the New York State

University College at Albany for planning and development. The college was then in the process of constructing a new multi-million-dollar campus in Albany and the Colonel's responsibilities were considerable.

Yet, during his remaining weeks in command, Colonel Tisdale was able to see a significant mark of the fuition of the research and development program at the Arsenal, the growth of which was mostly his doing. This was a gathering of nearly 200 researchers in the field of strategic materials who represented the Atomic Energy Commission, NASA and Army and Ordnance Corps research and development agencies. The Arsenal and R.P.I. were co-sponsors of the meeting, which was one of the largest of its kind ever held. The only thing to mar the success of the meeting was the inclement weather which forced back the airplane carrying Lieutenant General John H. Hinricks, chief of ordnance, and Honorable Finn J. Larsen, assistant secretary of the Army for research and development, from Washington.

The year-end review of the Arsenal's operations and developments for 1961 showed that employment, mostly of machinists and other metalworkers, had risen faster than was anticipated and the year closed with approximately 2,800 persons on the rolls. Colonel Tisdale noted with pride the expansion of research and development activities in the previous year and the accomplishments of the Operations Division management and workers in making missile motors. Procurement spending had increased 60% from the $20,000,000 figure of 1960 to a total of $32,000,000 at the end of 1961. Only a little more than half of the total procurement funds had been spent at the Arsenal, however, the remainder were distributed among industrial contractors on a nationwide basis. The Arsenal had begun delivery of Davy Crockett launchers in May and at the end of the year it could boast of a 90% record in meeting contract sched-

ules.

The first week of January, 1962, saw the opening of a new gate in the Arsenal's north wall and its dedication to the memory of one of the best remembered and most respected Arsenal commanders of recent decades. The Brigadier General Alexander G. Gillespie Gate, named for the Arsenal's World War II commander, was constructed by the Arsenal and paid for by the State of New York. The gate was part of a State Department of Public Works project to construct a viaduct over the Delaware and Hudson Railroad switching yards west of the Arsenal and thus eliminate an old traffic bottleneck where the Troy-Shaker Road passes across the yards. The project was four years in the making and the work was completed only after approval of the third State plan by the Arsenal, the City of Watervliet, the railroad and others. The first plan was eliminated because of Arsenal objections that the overpass, which would pass over a portion of Siberia, would interfere with the construction of its large new electric power substation in that area. The objection of the other parties disqualified the second plan and the third plan was accepted only after the state agreed to build the new Arsenal gate (since the old Shaker Gate would be cut off by the viaduct) and to curve the path of the viaduct so that it would not interfere with the Arsenal's facilities.

The completion of the gate and handsome gate house assured General Gillespie's name a permanent remembrance. The General died at Fort Myer, Virginia, in 1956.

However, by far the most important event of the early months of 1962 was assumption of command by the new commanding officer, Col. Keith T. O'Keefe, on February 1. A veteran of 21 years of service in the Ordnance Corps, Colonel O'Keefe was particularly well suited for command of the Arsenal both by training and experience. A native of New York City, the Colonel held a bachelor's degree in mechanical engineering from the City Col-

lege of New York and a master's degree in the same field from Brooklyn Polytechnic Institute, where he also taught for a time. He came to the Arsenal from command of the U.S. Army Overseas Supply Agency, which controlled the supply of materiel to Army forces throughout the world, and had formerly commanded Redstone Arsenal at Huntsville, Alabama, and Lordstown Ordnance Depot at Warren, Ohio. The colonel had also held a number of other responsible posts during his career including that of chief ordnance officer for the Mediterranean Theater of Operations during World War II and NATO posts in London, Paris and Washington in the years following. By way of distinctions, Colonel O'Keefe had been awarded the Bronze Star, the Army Commendation Ribbon with Oak Leaf Cluster, the Italian War Cross of Merit and the Crown of Italy.

The early months of 1962 brought again new projects and advances in manufacturing processes. Two of these projects, undertaken by the Inspection Engineering unit, were exemplary of the variety of the Arsenal's work in these active months. One was a study toward standardization of containers for missiles from the 34-foot Pershing to the 12-foot Little John; the other involved the design, testing and procurement of a container for an anti-tank missile.

Rapid threading, the process whereby the threads which join the gun barrel and breech are generated, was, paradoxically, modernized by the return to a pre-World War II method of effecting this operation. Before World War II, a single point cutting system was in use. Later, a multi-point thread milling machine was used for this operation, which was superior but expensive and complicated. In early 1962, the Arsenal returned to the single point system, but with the important features added that a modern carbide cutter was used and the operation was automated. A relatively inexpensive apparatus made it possible to carry out the op-

eration on standard lathes adapted for the purpose rather than on the $150,000 milling machine. The time required for this important operation was cut significantly and the cost reduced by as much as 75% per unit. While these savings in time and money were very welcome to manufacturing personnel, there was in the improvement of this process the large additional advantage of much increased production potential both at the Arsenal and in private industry.

Another major industrial process improvement introduced at this time was a new method of autofrettage or cold working. Ordinary cold working, that is the method wherein the metal was subjected to very high hydrostatic pressure in order to produce the strengthening stresses, had been in use at the Arsenal for many years. The new method, known as swaging, called for an oversized, sliding, conical mandrel to be forced through the gun tube. While this method produced good residual stress patterns, it required much less pressure and eliminated other cold working problems also.

That process improvements such as these were successful and immediately applicable to the work of the Arsenal was proven by the announcement in mid-February that approximately $1,000,000 had been saved on an order for 105 mm. M68 tank guns. The original estimate had been over $7,000,000 and the work of manufacturing the 900 weapons had been accomplished for a little more than $6,000,000. Most of the money had been saved on the working level; that is, study of all the turning, boring, reaming and milling operations revealed that many could be combined and some eliminated. The use of ceramic tooling in the turning operation proved especially economical.

At the beginning of March the Arsenal received another order to produce missile components for the Navy; this time for the sea-going Tartar surface-to-air weapon. The Tartar was a high altitude, supersonic weapon with

BENET FETE — Mrs. Rosemary Benet, left, wife of Stephen Vincent Benet, and poet Miss Laura Benet, Stephen's sister, attend dedication of Benet Laboratories in 1962.

a range of more than 10 miles which was designed to arm destroyers. The Arsenal undertook manufacture of the forward launcher shoes and after motor closures for the system.

Yet the missile work done at Watervliet, though significant, still remained a support activity. With receipt of an order for a quantity of new 8-inch howitzers a few weeks later, the "help wanted" sign was hung out at the Arsenal and recruitment of about 100 skilled metal workers was begun. Colonel O'Keefe noted in this connection the "constantly increasing emphasis being placed on the role of conventional weapons in the national defense."

In May, the strong emphasis on the expansion of research and engineering at the Arsenal, begun by Colonel Tisdale and maintained by Colonel O'Keefe, reached a milestone with the dedica-

tion of Building 40 as the Benet Research and Engineering Laboratories. The building had been entirely renovated to house the researchers and engineers, who were mostly in residence there by this time. Major General H. F. Bigelow in his dedicatory address noted the outstanding services rendered to Watervliet Arsenal, the Army and nation by Brigadier General Stephen Vincent Benet, former chief of ordnance, and his son, Col. J. Walker Benet, former Arsenal commanding officer. He cited the tradition of service at the Arsenal as represented by the contributions of the Benet's in former decades and Arsenal scientists in the presen.

At the end of May, the Arsenal found new employment for the equipment which had been used to produce the hypervelocity gun, the space probe equipment, and which had been originally used to make the major caliber seacoast and battleship weapons. This work was the machining of a huge component for satellite tracking equipment. The 11-ton piece, known as a torque tube, was prepared for the Massachusetts Institute of Technology to be incorporated into a radar system for tracking space probe vehicles.

A few weeks later the Arsenal received major responsibility for a new guided missile system for which its experience and skills were especially adapted. For, the Shillelagh, as the missile was called, was fired from a tank-mounted gun-launcher of special design and tank armament was and Arsenal specialty. The missile itself was an anti-armor, anti-fortification projectile. The Arsenal's role was complete research and development for the gun-launcher and missile container, as well as pilot line production of the former. Work on this important system was to receive much attention and effort from Arsenal scientists and engineers in succeeding months.

On July 1, 1962, Watervliet Arsenal severed a connection with the Office, Chief of Ordnance, of one-and-one-half centuries dura-

tion. The reason was the general Army reorganization that year, one of the major features of which was the elimination of the old-line technical services. Watervliet would now no longer report and answer to Washington directly, but would, rather, answer to the new parent organization — Army Weapons Command, located at Rock Island, Illinois. Watervliet Arsenal's partners under the new command were Rock Island Arsenal and Springfield Armory.

The reorganization of installations and activities, which thus affected the Arsenal, into new groupings by commodity and service, was part of the great Army effort to streamline and modernize itself to be better able to meet the urgent demands placed upon it for national defense in the nation's unremitting cold war with a relentless enemy.

Reorganization brought an addition to the Arsenal's regular mission. The task of research and development of recoilless rifles, formerly centered at Frankford Arsenal in Pennsylvania, was now transferred to Watervliet. The Arsenal already had the responsibility for all other phases of these weapons and this addition made the Arsenal the center for the whole program. The Arsenal's responsibility for research, design, development, testing and evaluation, industrial engineering, procurement, production, maintenance engineering, new equipment training and technical assistance to users for all cannon, mortars and related secondary items continued.

By the time of the closing of the Arsenal manufacturing departments for the July 2-15 vacation shutdown, employment had risen to 3,200 employees. The figure had risen by about 60 persons at the time reports on the fiscal year ending June 30 were available in early August. The reports showed that the average arsenal worker's salary was $6,355, due to increased employment and wage raises. The annual payroll at this time was calculated at $20,700,000 and a raise for classified position

workers two months later promised to raise this to $21,000,000 for 1962.

Two months later the first production models of the 175 mm. gun and the new 8-inch howitzers were turned over to the troops. These Arsenal weapons were the ones of which the Army was particularly proud. Together with the other members of the modern Arsenal-developed artillery family, the 105 mm. and the 155 mm. howitzers, they met all the stringent requirements for high rates of fire, accuracy, field mobility and air transportability set down years before.

The 105 mm. and 155 mm. howitzers were interchangeable in one fast, long-range vehicle, as were the 8-inch howitzer and 175 mm. gun in another. The excellence and flexibility of the system these weapons comprised promised that the nation's enemies would face a new and formidable concentration of power on any future battlefield.

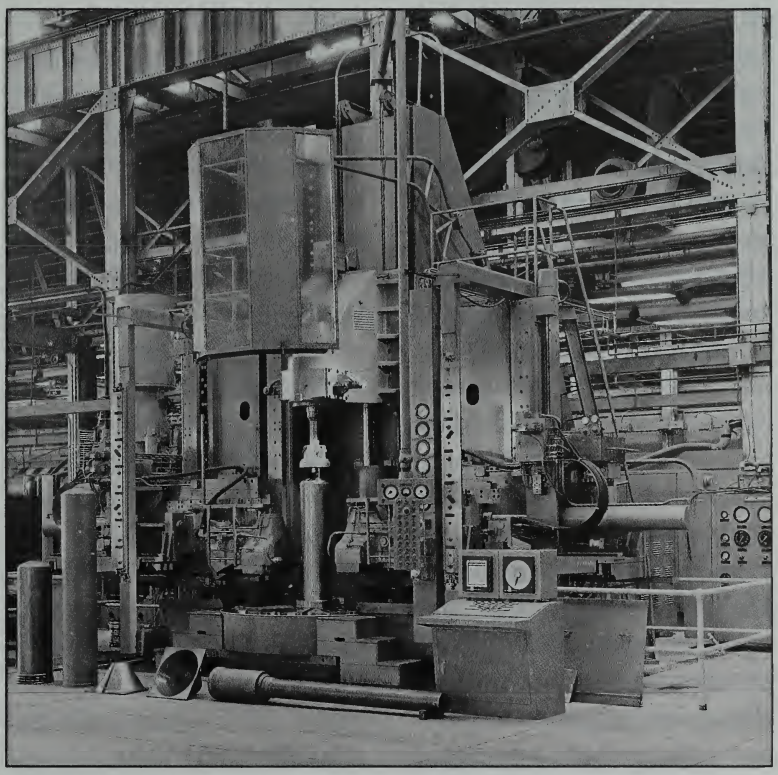
Lieutenant General Frank S. Besson, Jr., chief of the Army Material Command, parent organization to the Army Weapons Command, accepted the guns on behalf of the Army and stated that they were "a historical step forward in our battle to provide the Army with mobility." The 175 mm. gun and the 8-inch howitzer replaced five guns previously used. The were the 155 mm. gun, 8-inch gun, 240 mm. howitzer, 280 mm. gun and the older versions of the self-propelled 8-inch howitzer.

August and September brought two new developments in gun manufacturing processes. The first was a new method of honing developed to meet a problem which arose in manufacture of high strength, thin walled tubes such as Davy Crockett launchers. With the older method the honing head revolved while the tube and rest remained stationary. With this method, however, it proved difficult to keep the proper concentricity. Arsenal engineers found that the difficulty could be eliminated by revolving the honing head, the rest, and the tube. The second advance was conse-

quent on the introduction of a rapid boring machine which, with an automated operation, could bore out gun tubes three times faster than previous methods. For example, a 105 mm. howitzer tube could be bored in one hour by the new method, compared with five hours necessary with the old.

In September also, the Arsenal received three orders which contributed to the continued stabilization of the work load. The first of these was for manufacture of a quantity of 105 mm. tank guns, in keeping with the installation's chief mission, and the other two were support orders. The first was for a quantity of booster motors for an advanced model of the Navy Terrier missile and the second called for production of assembly components for the M85 machine gun, to be mounted on the M60 tank.

Another unusual piece of equipment was installed at the Arsenal during October in connection with the work being done on missile motors. The machine, known as a spin former, was basically a huge potter's wheel. That is, a cored cylindrical piece of metal was placed on the top of a mandrel, the outer form of which was identical to the interior configuration of a missile motor. As the mandrel was started spinning at very high rates of speed, heavy rollers would begin to press against the metal piece with pressures to 70,000 pounds per square inch. Gradually, the metal piece was thinned and stretched down over the mandrel and assumed its shape; or rather the shape of the missile motor. When finished, the metal piece, originally 14 inches long and seven-eighths of an inch thick, was six-and-one-third-feet long and one-eighth of an inch thick. The machine was constructed by a private manufacturer to the Arsenal's specifications and was designed to counter the difficulty involved in achieving the necessary degree of precision in thin-walled missile components by ordinary machining methods. The apparatus was particularly valuable in making motor casings for the Tartar missile, but was used also to produce



SPIN FORMER — Like a huge potter's wheel, hydro-spin machine forms Tartar missile motor case in 1962.

drone missile motors and Davy Crockett launchers.

In October, it became known that Arsenal workers had achieved a particularly heartwarming success when tallies showed that contributions to the United Community Services Fund, which encompassed many local charitable activities, had passed $22,000 in that year's drive, the largest amount thus far contributed.

While the amount contributed during this period was particularly praiseworthy, it was, however, only indicative of the continuing generosity of Arsenal workers over the years. The large amounts contributed to local and national organizations were yearly occurrences and

if totalled would no doubt amount to a very large figure. Yet, in addition to these formal drives, the charity of the Arsenal workers found many other interesting and unusual expressions. Examples of these were the contribution of an iron lung to Samaritan Hospital, in Troy, and donation of about $10,000 worth of skilled labor towards renovation of Vanderheyden Hall, a Troy orphanage, in 1956; "Operation Sleighbell," an annual Christmastime project, begun spontaneously in 1958 and continuing for several years thereafter, wherein employees estimated the amount of money they would ordinarily spend sending each other Christmas cards and, instead, donated it to needy children, and projects begun in 1961 in which individual groups of eight or nine workers agreed to contribute a dollar each per month to the support of underprivileged children in other countries. It would seem that such a record for varied and continual charitable activity would be truly unique among organizations of the Arsenal's type.

At the end of October, the Arsenal received orders for more than $5,300,000 worth of its own modern weapons — 105 mm., 8-inch and 155 mm. howitzers and while it was another "bread and butter" order requiring no additional hiring, it was a good sign of the apparently continuing prosperity of the installation. Indeed, at the end of the year Colonel O'Keefe was able to state that "Emphasis has been shifted in the last two years...so that we will be better able to wage conventional war." The Colonel noted that the Arsenal had spent $30,000,000 in the previous year, two-thirds of which had gone to pay the salaries of the approximately 3,200 employees. Employment had risen by 700 persons over that of 1961 and Colonel O'Keefe was able to point with pride to the fact that, due to emphasis on research, development and scientific management, the Arsenal staff now contained 11 persons with doctoral degrees, 67 master's degrees and 251

bachelor's degrees. More than 100 young men enrolled in the apprentice machinist school promised "new blood" in the manufacturing areas.

The Arsenal had $42,000,000 worth of orders on the books, much of which would be handled by private industry. The specifically gun producing facilities built up in industry during the Korean War were, however, largely gone by the end of this year. Prior to the end of production at these facilities, at the end of the war, arrangements had been made with the producers to manufacture certain items in the event of future emergency. Many production lines were left intact at this time, but funds for this purpose were constantly whittled away in the years following. Yet the situation at the end of 1962 remained much better than in the post-World War II period. For, while the production lines had been dismantled, the equipment was still earmarked for specific places and items and it was estimated that all facilities could be installed at the producer's site in 60 to 90 days.

Ridgewood Ordnance Plant, Lima Ordnance Steel Foundry, Dixon Gun Plant and the government-owned facilities at Cameron and Bethlehem Steel companies were still intact and ready for almost immediate operation. In addition, Firestone Tire & Rubber Co. was manufacturing 90 mm. gun tubes and 90 mm., M67, Recoilless Rifles and the Wheland Company Division of Gordon Street Machinery Corporation was making 105 mm. gun tubes.

It was, in all, a full picture of steady work, high employment, high wages and high service which Watervliet Arsenal presented as it stepped over the threshold of 1962 into 1963, its 150th, Sesquicentennial Year, with the easy stride of one who has done difficult things well and faces the future with confidence.

Chapter 12

The Southeast Asia Buildup

The year 1963, the one hundred and fiftieth from the founding of Watervliet Arsenal, passed in such a way as to confirm Colonel O'Keefe's forecast of some months before: that the pendulum of policy emphasis in high defense planning circles was swinging gradually from a posture in which nuclear weapons overshadowed all other arms, to a stance offering varieties of response to changing circumstances. An important role for conventional arms was a keystone of this new development.

The orders for the Arsenal's own new family of artillery weapons, measured in hundreds of items and million of dollars, continued through this year, through 1964 and the first half of 1965. The organization of new artillery units to be armed with the Arsenal-made 175mm. M113 Gun, the heaviest conventional weapon in the Army's inventory, created a continuing need for these and the rearming of units-in-being with the latest weapons did the same for the 155mm. Self-propelled Howitzer M126 and 8-in. Howitzer

M2A1E1, the 105mm. M68 Tank Gun, the light towed 105mm. Howitzer M137 and self-propelled 105mm. Howitzer M103.

There were intermittent, but important, orders also for the 106mm. Recoilless Rifle (BAT), the 4.2-in. M30 Mortar, some older tank weapons and other guns and components.

The new Arsenal weapon orders although sometimes quite large (as with an initial $7.5 million order for 175mm Guns in May, 1963, from the Federal Republic of Germany, a NATO ally) were still regarded as 'bread and butter' orders, i.e., they required no special expansion in man-power or facilities, but rather were enough to keep things functioning at a normal level.

In June, 1963, the Arsenal reached the long and elaborately prepared for time chosen to celebrate its century and a half long role in helping to safeguard the liberty of the nation. Although the efforts of the Arsenal staff to bring this landmark date to the attention of the public had begun in January and would continue through the year, the high point of the observance was Sesquicentennial Week, June 8-15.

The celebration began on Saturday June 8, appropriately with a picnic for the Arsenal employees themselves. A considerable success, more than 7,000 employees and members of their families attended the all-day event. Among the wide variety of entertainments offered for their amusement were "sky-divers," a musical review, movies for children and general dancing for all.

The more serious events commenced the following Tuesday with a luncheon to honor the winners of the Sesquicentennial Essay and Poster contests which were open to high school and seventh and eighth graders respectively. Wednesday was Recognition Day which featured memorialization of three Arsenal buildings: Building 10, the administration building, was named Campbell Hall for Lt. Thomas Campbell, prominent in the early years of the

Arsenal's founding; Building 44, the gage building, named Dalliba Hall for Maj. James Dalliba, founding Arsenal commanding officer and pioneer in military metrology; and Building 115, research laboratory, named Maggs Research Center for Albert H. Maggs, former Arsenal chief of research who was killed in an airplane crash while travelling on Arsenal business. The evening of Recognition Day the Sesquicentennial Banquet was held with Maj. Gen. Nelson M. Lynde, USAWC Commanding General, and former Arsenal Commanding Officers Harry N. Rising and Walter M. Tisdale as guests of honor.

Plans to climax the celebrations with a parade and review scaled to overshadow the famous 1919 Field Day in celebration of the World War I victory came to naught when a heavy day-long rainfall on the final Open House Day, Saturday, June 15, forced cancellation of the scheduled parade. There would have been hundreds of units and 2,000 marchers. As it was, more than 16,500 persons visited the grounds during the day, including a self-styled "peace marcher" group who picketed the main gate on Broadway. Carrying anti-war signs and passing out such literature, the small group of students and near-students attracted little notice until one of the demonstrators considered it his duty to line down on the sidewalk. The Watervliet city police in attendance considered it their duty to remove him. It was apparently the only time in the Arsenal's long history that such an event had taken place. The draft rioters of 1863 had threatened to attack the post but changed their minds. On all other recorded occasions when citizens carried signs to or through the Arsenal gate, their messages were laudatory. The 30 months from January 1963 through June, 1965, were fruitful from the point of view of improvements in manufacturing processes and the expansion of scientific knowledge concerning weapons manufacture.

Electronic telltaling and sensing were two such shop

ULTRASONIC TESTING — Ultrasonic technology is applied to quality testing of cannon tubes.

improvements which aided greatly in accomplishing the one most unique manufacturing task in Watervliet Arsenal's purview: cutting a long straight hole through a cylinder. These new methods called for electronic sensors inside and outside the gun tube which transmitted data to indicate whether the bore was being bored straight in one case and in the other whether the walls of the tube were being shaped to the symmetrical thickness called for by the specifications. Both devices indicated further steps away from the traditional means of strictly mechanical measurement to acquisition of absolute data for comparison to precise standards. Two other instances of the application of this principle during this time were the use of automatic ultrasonic testing and the telecontrol system. Ultrasonics, used to detect flaws or cracks in tubes, while not new, was much improved at this time and the refinements incorporated allowed detection of much smaller cracks than formerly. Tele-control

was the name given to an electrical system of production control installed in Building 25, where most smaller components were made. It operated by means of sensors located at the work stations which transmitted data on the progress of work, stoppages etc. to a central control room where the data was continually monitored. It thus allowed a small number of supervisors to keep a large degree of control over many operations. It was the first application of this management tool within the federal service and prompted much favorable notice within the Department of Defense.

During this time the search for improved materials for weapons continued and produced such notable items and events as the first use of a plastic tube for recoilless rifles, electro-deposition of dispersion hardened alloys in aluminum and other metals, and the growth and use of 'whiskers' on an experimental scale. These latter were microscopic rod-shaped crystals of various metals grown in high temperature furnaces and imbedded in other materials to strengthen them in much the same manner as the steel reinforcing rods strengthen concrete constructions. This effort and others of the kind were part of the continuing struggle to find the elusive optimum strength to weight ration in gun making materials. Simulated testing devices received the successful attention of Arsenal experts during this period also. One apparatus employing a hydraulic system and a kind of pile-driver made it possible to apply the pressures of firing to breech assemblies and breechblocks so accurately that in some cases laboratory data could be interchanged with actual rounds fired on the proving ground ranges. The cost of proof testing by this means was greatly reduced, e.g., a 90mm, tank gun could be "fired" in this way for 25 cents per "round" compared to $35 per round for real ammunition. The time involved was also greatly reduced. Another system made it possible to apply full howitzer firing pressure

to bore evacuator valves by means of firing blank .30 Cal. ammunition in an adapted rifle mechanism.

Over-all planning for current and especially future weapon needs continued through this time and Arsenal representatives in the usual course of business attended many professional conferences of learned societies, government and armed service organization. On an international level, Arsenal men and women journeyed to India, the Netherlands, Israel, Germany and England to help the United States honor its NATO and other defense commitments. Watervliet Arsenal, however, was sometimes the scene of these planning gatherings. In June, 1963, the 9th Conference of Army Mathematicians met at the Arsenal for two days, bringing together scientific representatives from virtually all other Army research establishments in the country. The group heard a further appeal from Colonel O'Keefe for "continued Army support of research, development and engineering, particularly in conventional weaponry." Again in September of that year the Pentagon-level organization U.S. Army Material Command (of which the Arsenal was a part) conducted a two-day Artillery Symposium at the Arsenal to consider the broad picture in current and future artillery needs, ammunition development, fire control systems and possible new weapons. In a like manner, the USAMC Weapons Advisory Group toured and inspected Arsenal facilities in June, 1965. This group, however, was composed of representatives of private industry, engineering and technical schools, rather than government representatives.

November 22, 1963 was a day long to be remembered by the Arsenal employees who first received the shocking impressions of that tragic day while at their work. The news of the shooting of President John F. Kennedy while he was travelling in a motorcade in Dallas, Texas, first reached the employees by means of radio broadcasts and quickly spread through the

installation. Excitement and consternation were high as it was not known for about one-half hour that the shooting had been fatal. When it became known that the President was dead, dismay and sorrow were general, despite private political points of view.

The post flag was lowered to half staff that afternoon, although official notice of the tragedy did not arrive until the next day when a general order was received from Secretary of Defense Robert S. McNamara couched in a language similar to that of the one on the same topic received at the Arsenal almost 100 years before: "I have the sad duty of announcing to the Armed Forces of the United States the death of John Fitzerald Kennedy, the President of the United States, who was the victim of an assassin's bullet Friday, November 22. The world has lost a gallant spirit whose championship of freedom and opportunity will be recognized by history.

"All members of the Armed Forces, whose welfare was his concern, can pay no better tribute to his memory than to carry on in the tradition which he shared and of which he was so proud.

"Colors will be displayed at half mast for 30 days, beginning Nov. 22 west longitude date."

The new President Lyndon B. Johnson described the assassination as "...an act which outrages decent men everywhere....All who love freedom will mourn his death." The President appointed the following Monday to be a "day of national mourning," and said "I earnestly recommend the people to assemble on that day in their respective places of divine worship, there to bow down in submission to the will of the almighty God, and to pay their homage of love and reverence to the memory of a great and good man."

The Arsenal was closed on the day of mourning and the people of the Arsenal as well as their countrymen in the millions used the day to follow the recommendation of the new President and to view the solemn and majes-

tic events of the funeral and interment.

This period was also remarkable for the beginning of serious union development at Watervliet Arsenal. While there had always been some interest in trade-unions and government employee unions, the organizations which had resulted from this interest were poorly supported by the workers and largely ineffectual. The situation took on another complexion after the publication in February, 1962, of Executive Order 10988 signed by President John F. Kennedy. This document was hailed as a kind of Magna Carta for unionism in the federal service, since it went a good deal further than any previous executive document on the subject and enjoined upon the directors and managers of both civilian and military agencies and installations an "affirmative willingness" to cooperate with employee unions. Indeed, the early enthusiasm with which the Executive Order was received was not dimmed by later events, since unionism in the federal service flourished everywhere in succeeding years under its protection and encouragement.

In the middle of December, 1963, a public announcement was made that the American Federation of Government Employees would hold an organizational meeting for the employees of Watervliet Arsenal a few days later. This was done and a small nucleus of an AFGE Lodge was formed with Mr. Richard J. Walsh, an Arsenal program analyst, as leader. Six weeks later, the Lodge had 200 members, representing 10% of the Arsenal workforce, and was granted "formal recognition" by Colonel O'Keefe. A few days later the Lodge elected Mr. Walsh its first president and began to negotiate for a regular "dues checkoff", that is, payroll deduction for members. Thus fairly launched, the growth of the AFGE Lodge was rapid and steady in ensuing years. By September 1965, the organization had received "exclusive recognition", another important developmental step,

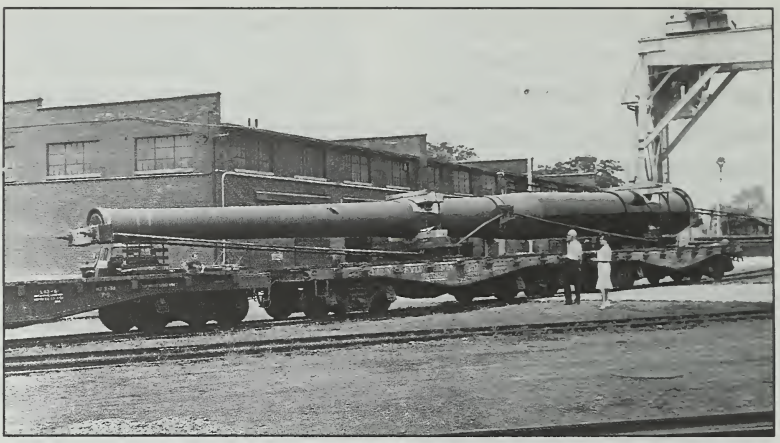
which meant that with the 1,300 members it now had, it was the spokesman in labor-relations matters for 2,200 of the 2,849 persons employed at the Arsenal. Persons in managerial and policy making positions were not allowed to hold office or take an active part in union affairs lest they become compromised by conflicts of interest arising from their duties.

Another union had its beginning in these years. The Watervliet Arsenal Federation Federal Credit Union was organized in March, 1964, with only a handful of members and through a campaign launched in the columns of the employee newspaper The Salvo. The membership grew through leaps and bounds as the program of low interest loans and financing offered by the organization (a participant in a general system of such organizations throughout the federal service) compared very favorably with those offered from private sources. The organization, whose members bought shares and received dividends on their deposits, maintained offices in the cafeteria with hours suited to the convenience of the membership. The officers, members of the board of directors and credit board were elected from the membership yearly. By the following January, the organization had a membership of more than 900, assets of more than $112,000 and had handled almost 500 loans worth about $170,000. It continued to grow in these proportions in the coming years.

Another employee organization which had its beginning at this time was started in March, 1964. Called the Watervliet Arsenal Toastmasters, it was a unit of a national organization founded to foster ease and proficiency in public speaking. Employing a system of regular prepared and extemporaneous talks before the members as the means of attaining these goals, the organization was welcomed by employees both as a recreation and a means of developing a useful management skill.

The last months of 1964

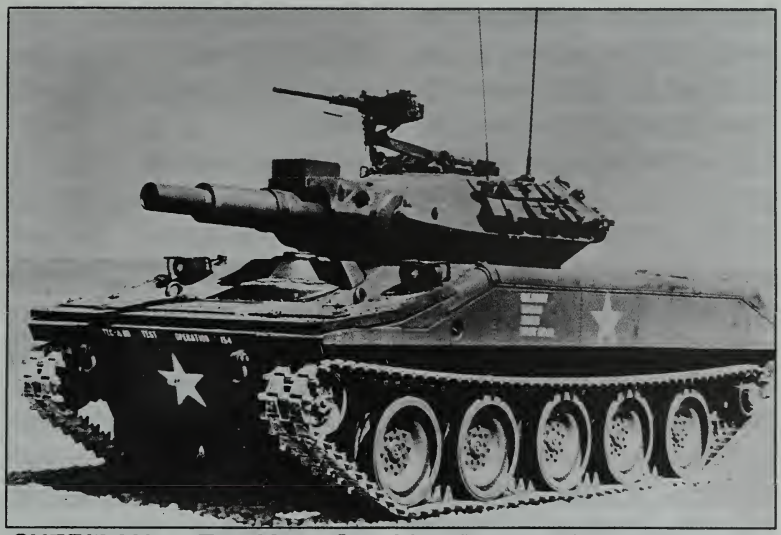
and the first of 1965 saw yet another rumor of closing visited upon Watervliet Arsenal. The fears of some employees did not seem entirely without grounds, however, as there was at the time a powerful impetus in favor of "cost-effectiveness" emanating from the Pentagon and the names of many famous armed services installations, which had rendered long service to the nation, appeared on the lists of those proscribed to soon close their doors. Two of the Arsenal's oldest associates in national service, Springfield Armory and Watertown Arsenal, were on the list of those considered expendable. One of New York State's United States Senators, however, interviewed high level Army officials and reported that the rumors were probably the result of confusing Watervliet Arsenal with Watertown Arsenal. In February, 1965, in view of the pending "phase out" of Springfield Armory, a local Congressional Representative presented arguments to Pentagon officials to the effect that the Springfield small arms function should be transferred to Watervliet. He stated that more than one-third of the skilled work force could be expected to accept a transfer from Springfield to Watervliet, thus maintaining the integrity of their skills and the continuity of the work in small arms research and development. These arguments had no effect, however, on the disposition of the affairs of Springfield Armory, although the course of future events proved them to have been approximately correct. These maneuverings did bring renewed assurances of the secure future of the Arsenal, however. At Watervliet Arsenal, in any case, the uneasiness about closing probably drew some strength from a RIF of 49 persons in April of 1964, which reduced total employment to 2,972, and another RIF of 49 persons in January 1965, which brought the employment figure to the further reduced level of 2,840. These RIFs, though affecting but small numbers of employees, drew new attention



HARP — A tube produced for Project HARP (High Altitude Research Project) is ready for shipment.

to the gradual but steady decline in employment which had seen the workforce reduced by more than 300 persons since January, 1963, alone.

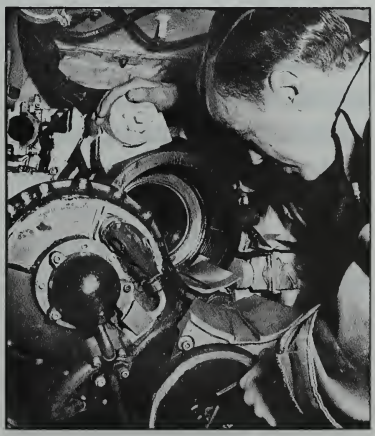
During the first months of 1965, orders continued to be received for the weapons which were already a part of the Arsenal production and procurement inventory. However, as usual, there were unusual tasks such as the manufacture of equipment for use in the High Altitude Research Project, or HARP, being conducted at sites in Wallops Island, Virginia, Barbados Island in the British West Indies and White Sands, New Mexico. The equipment consisted mainly of lengthened, smoothbored guns to act as controlled launching devices for missiles treated as projectiles. Most of these were made in five and seven inch caliber but the largest, for use by the joint American-Canadian research team at Barbados, was a 16-inch naval gun. The leaders of these projects pointed to several advantages: extreme economy in comparison to pure rocket systems, since the launchers were readily available artillery pieces and used ordinary artillery propellant; they overcame the critical moment



SHERIDAN — The M551 Sheridan Reconnaissance vehicle with arsenal's 152mm M81 gun launcher.

of weakness in pure rockets, i.e., the few seconds after ignition when the vehicle is lifting slowly from the pad and is vulnerable to deflection by atmospheric conditions, by using the extremely fast acceleration of the artillery propellant to quickly escape the strata of the atmosphere affected by winds and other adverse factors.

In April, the Arsenal received a $20 million order for the manufacture of the first new weapon to be added to its inventory since the 175mm.M113 Gun a few years earlier. This was the 152mm. Gun/Launcher XM81E12, chosen as the armament of the Armored Re-



LAUNCHER — Close-up of launcher mechanism.

connaissance Airborne Assault Vehicle known as the General Sheridan. An almost identical weapon (the only difference was a different mounting adaptation) was developed for the M60 Tank as well. Another version of the weapon, designed on the same principles and with the same 152mm bore diameter but with even more potent ammunition was soon to be developed for the MBT 70 or Main Battle Tank, development of which was a joint project of the United States and the Federal Republic of Germany. Each weapon employed a unique powered automatic breech mechanism with a separable breech chamber. Each was designed to fire either a conventional round of ammunition or a rocket capable of defeating any armor likely to be designed. The work on the General Sheridan weapon was to be completed over a period of four years and followed several years of research and development begun in 1959. Actual preparations for manufacture of the weapon had begun with a three-quarter of a million dollar allocation of advance production engineering funds in August, 1963.

In mid-June Colonel O'Keefe announced that he would bring his 33-year United States Army career to a close at the end of the next month. During his three and one half years as the Arsenal commanding officer, Colonel O'Keefe made many friends within the Arsenal and the community through his friendly and active manner and, through the application of his professional abilities, earned the respect of his colleagues as well. His tenure in the executive office of the installation saw many changes for the better in organization, management practices and the scope of scientific activities. At the retirement ceremonies Brigadier General Charles Prosser, Deputy Commander, U.S. Army Weapons Command, presented Colonel O'Keefe with the Legion of Merit Medal for his contributions to the successful work of the Arsenal during his command. Thousands of Arsenal work-

ers attended a farewell ceremony for Colonel O'Keefe on the parade ground, presided over by Maj. Gen. Roland B. Anderson, the day before his retirement was effective. After retirement Colonel O'Keefe accepted the post of city engineer with the City of Troy but after a brief term there, he returned to the field of rocketry, in which he had had earlier experience at Redstone Arsenal.

The thirty-seventh commanding officer of Watervliet Arsenal, who took command immediately after Colonel O'Keefe retired, was Col. Fred Kornet Jr. Colonel Kornet, who left the post of Executive officer of the U.S. Army Combat Developments Command's Institute of Advanced Studies at Carlisle Barracks, Pennsylvania, to come to Watervliet Arsenal, was an Army career officer with 25 years service. A native of Wortendyke, New Jersey, he was a graduate of Lehigh University with a bachelor's degree in chemical engineering. He later received a master of business administration degree from the University of Chicago and was a graduate of the Army Command and General Staff School and the Army War College. Colonel Kornet had served in Europe during World War II and had later tours of foreign service again in Europe and Korea. The Colonel was also no stranger to the work of Watervliet Arsenal, having served at Watertown Arsenal on projects connected with the development of the 280mm, Atomic Cannon.

Almost simultaneously with Colonel Kornet taking command, the decision was made in Washington policy circles to begin major troop commitments to the defense of the Republic of South Viet Nam, then hard pressed to maintain its freedom in the face of internal terrorism and subversion and the invasion of hostile forces from the north. The United States armed forces had been aiding the fledgling nation to defend itself through military assistance program activities with advisers and materiel. Some of this materiel had come from Watervliet Arse-

nal. Included were not only the mission artillery weapons, recoilless rifles and mortars, but high priority items such as bomb racks for the Air Force and multiple rocket pods to be mounted on Army helicopters for close ground support missions. These latter were "02" priority (next to highest) systems critically needed. They were transferred to Watervliet Arsenal from other installations and private concerns which were unable to complete them in the necessarily brief time.

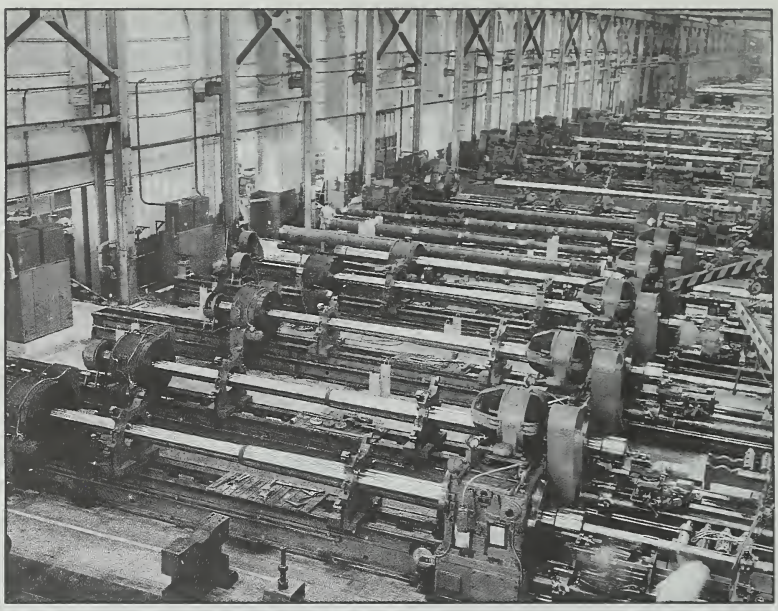
Yet, while staff members were pleased to receive these orders and somewhat astonished the customers by the speed with which the Arsenal was able to respond to their urgent battlefield requirements, they were only ripples, so to speak, caused by the vastly serious events taking place far off in Asia. What occurred in the summer of 1965 was a far more immediate stimulus, for with the commitment of American fighting men on a large scale, the orders for the Arsenal's modern conventional weapons came in a flood.

Colonel Kornet pointed out in an interview at that time the "Viet Nam buildup is being reflected...at the Arsenal," and that the brisk tempo of Arsenal work would probably continue without diminution in the foreseeable future." He explained, in understatement, that some recent orders related to "immediate military needs." Only a few days later four orders were received totalling $2.7 million for 105mm, and 90mm, tank guns, the 152mm, gun launcher and 106mm, recoilless rifle. Again, only about 10 days passed when orders for $2.4 million worth of 8-inch howitzers were received. These and the frequent and varied demands for battle field equipment which followed through the succeeding year underscored and added weight to the Commanding Officer's predictions.

The burden of the effort to meet the demands of the crisis was to fall to the Operations Division and the Procurement Division: in a way, the work of the researchers

and engineers was finished and it remained but to see whether the products of their years of study and effort would stand the greatest and most final test — combat.

The Procurement Division's total program authority for this first 12 months (June 1965 to June 1966) of the "Viet Nam build-up," as the war came to be known, was $106,854,000, approximately triple the annual levels for the three previous years. In the Operations Division, Procurement Division orders marked "SEA," for Southeast Asia, began to be received in an ever increasing volume for 60mm, and 81mm, mortars and spare parts for the 40mm, gun, and significant increases were registered in the orders received for 155mm. Howitzer M126 (well over 600 of these complete or spare barrels were shipped through the year requiring expanded production facilities), 8-in. Howitzer M2A1, the 105mm. Howitzer M137 and 106mm. Recoilless Rifle M40 and Mount. Urgent spare parts orders were also received for manufacture in the Arsenal of 76mm. Tubes M32 (which required that the necessary tools and equipment be removed from storage and a production line established for this item) and 40mm. Tubes M2A1. Urgent nonmission requirements were also laid upon the Arsenal for 20mm. M39 Drum Assemblies but most notably for 40mm. Grenade Launcher Barrels M75. The latter item provided an illuminating example of the versatility of Arsenal managers and workers. The grenade launcher (used on armed helicopters) had proven itself a very successful weapon under the combat conditions in Viet Nam and high-ranking Defense Department officials placed the greatest stress on filling the requests from the battlefields as soon as possible. Springfield Armory was given the task of manufacturing 1,800 of them but was hampered by the circumstances of its progressive phase-out and difficulties with manufacturing techniques. The order was transferred to Watervliet Arsenal,



GUNLINE — 175mm guns in high production in Building 110in 1963 for support of Southeast Asia effort.

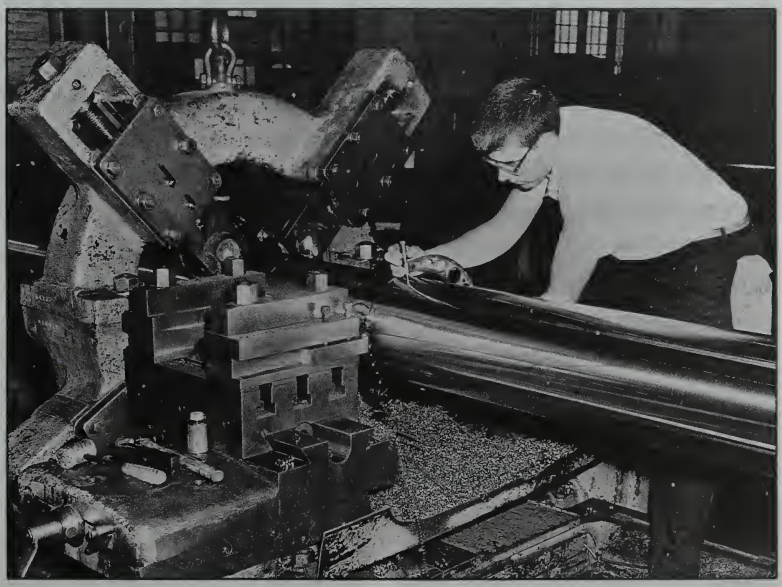
although the Arsenal had never made the item before and lead time was extremely short. Arsenal officials were informed that there were none of these items left in stock with which to fill orders from the using services. Nevertheless, the Arsenal delivered 125 of the grenade launcher barrels a month in advance of the due date, to the surprise and happiness of the customers. The remainder of the order (3,600 units) was completed on schedule as well, to the further amazement and delight of the user services.

An interesting procedure set in motion in March, 1966, designed to bring urgently needed battlefield items into the hands of the troops as quickly as possible was "Operation Red-Ball." With the colorful nickname drawn from the famous road convoy teams which had sped supplies from the French invasion harbors to the swiftly advancing mechanized units in World War II, the designation "Red-Ball" conferred the highest priority on any order

to which it was applied. Such orders were acted upon immediately when received and were accompanied by automatic authorization for "around the clock" overtime if necessary.

Still, while the level of Arsenal activity was everywhere stirred by the events in South Viet Nam, the imperative and governing influence at the arsenal was the demand of the fighting services for more 175mm. M113 Guns. For, while the value of weapons manufactured at the Arsenal soared to $57 million during the fiscal year (June 1965 to June 1966) which was an increase of $39 million or 200% over the previous fiscal year, approximately 26% of the total amount, or $15 million, went to satisfy the demand for 175mm. M113 Guns.

The sources for this sudden and great demand for the largest conventional weapon in the Army's inventory were twofold; on the one hand a source of pride and congratulations and on the other



175mm — Measurements are taken during metal-cutting work on a new 175mm gun tube.

misfortunate. In the summer of 1965, the first 175mm. gun artillery units arrived in Viet Nam and began to take part in operations. The gun with its very long range and accuracy was an immediate success in the difficult battlefield conditions then prevailing: from the carefully sited fire bases they were able to reach out and strike enemy forces attacking at widely dispersed points and they alone were able to provide the major defensive fires when the changeable tropical weather grounded air support.

The difficulty arose when a 175mm. gun burst before it had reached its rated fatigue limit. The certified life of the gun barrel was therefore reduced (meaning more barrels were needed for the same rates of fire) until new tests could be made to determine the fatigue life with a greater precision. These factors, then, greatly increased the demand upon the Arsenal for replacement weapons.

The second year of the buildup followed along the line of the first: the 175mm. gun dominated the demands made for weapons, "Red-Ball" requests were even more frequent (210) and 02 priority was extended to cover the 155mm. Howitzer M126E1 and the 152mm. Gun launcher M81. Indeed the emphasis was so strong on manufacture of heavy weapons, that the Arsenal had to place some orders for mortars and recoilless rifles with private manufactures to free the manufacturing facilities for heavy weapons.

An all-out effort was made to increase the capacity for output of 175mm. Guns from the 25-30 per month level of June 1965 to that demanded by the field forces. The capacity to produce 175's was increased to 60 per month in the first year and to 120 per month in the second year, although the highest actual monthly production rate was 110, reached in the second year of the "SEA buildup."

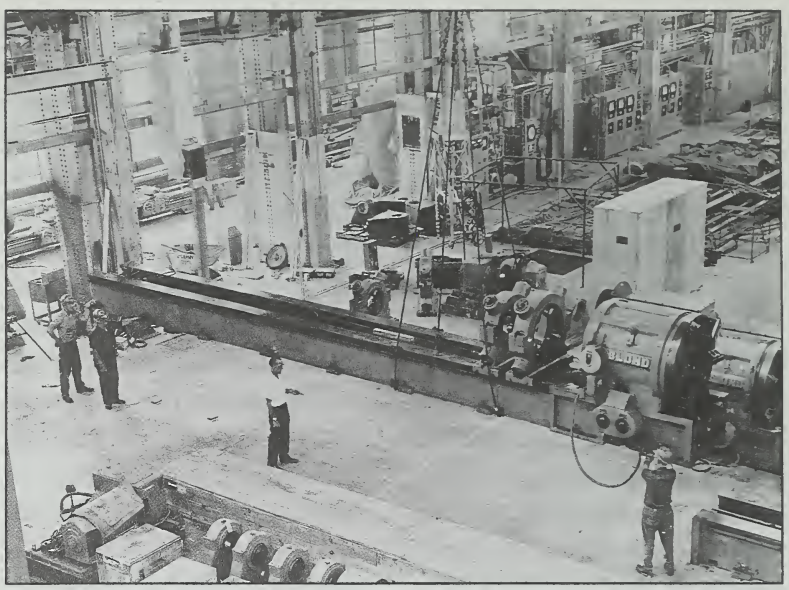
This was made possible by an expansion of chrome plating facilities and manufacturing capability for the weapon. In these circumstances of pressure and necessity the carefully drawn

plans of many years had their effect and the lessons learned in earlier crises were applied through the mobilization program developed after the Korean War. Formal, technical "mobilization" did not take place however. High authorities deemed that the needs of SEA could be met with emergency procedures short of formal mobilization, which would have given the government agencies the power to assign work, fix prices and control labor and materiels and apply penalties in cases of default.

In any event the grinders, presses, rifling machines and other tools were on hand in "Siberia" and elsewhere when they were needed. The government was spared the astronomical cost of purchasing all of this equipment new (a practical impossibility in any case), but most important, the soldiers facing the enemy were spared the effect of the 18-24 month procurement-to-production line time lag which would otherwise have occurred. Most of the machines had been rehabilitated before layaway and little work was necessary to put them to immediate use. Thus, the concomitant expense of expansion, though large by any objective standard, was relatively small and the delivery schedules made possible were, as one Operations Division official could truthfully say, "enviable."

The spirit of the days was clearly shown by the remark of Mr. F. J. Clas, the chief of the division, in May, 1966, at the end of the first year of the buildup: "The bell has rung and we are answering it," he said pointing to the fact that the Arsenal was delivering a greater variety of weapons to Viet Nam than any private company. He stated proudly that the Arsenal had missed no delivery dates up to that time (nor did it later). But these successes were not achieved without difficulties or moments of anxiety; for while the machine tools could be brought from layaway and put almost immediately into the production line, the trained workers to man them were not so easily obtainable.

The Arsenal, like many



OUT OF STORAGE — A machine tool is taken out of storage and installed in Bldg. 110 to meet production demands.

other defense installations, found itself in a somewhat paradoxical situation since, although the United States had several hundred thousand troops committed to combat with a foreign enemy, life in the United States was virtually untouched by the far-off fighting. There was, as mentioned above, no general mobilization, and the national economy, already at an all-time high when the United States actively entered the war, only throve the more when military spending increased. The result of these facts for the Arsenal was that when the "bell rang" and Arsenal recruiters went into the labor market there was almost no one there.

Personnel officials began an intensive effort to find the machinists, toolmakers and experienced machine tool operators to fill the many spaces in the expanding production lines but had little response since these skilled people had been absorbed by private enterprise and could not be enticed to enter federal service through the short term appointments which were all

that could be offered to them. Heavy use of overtime began with the regular Arsenal workforce in June 1965 and a year later more than 1,000 employees were working the equivalent of a six-day week and three shifts were in operation. Since, however, the large number of operators needed had not been forthcoming, Arsenal officials made the decision to reactivate the wartime machine tool operators course which had been the successful last resort in World War II and the Korean War.

In January, 1966, also a class of 15 machinist apprentices was hired and Arsenal training officials took the opportunity to point out once more a lesson that hardly needed a new demonstration, so often had it been repeated in the past: these 15 men were the first class to be hired in more than three years and the Arsenal need not then be feeling the pressure of a serious skilled labor shortage if higher authorities had permitted a steady functioning of this vital source of talent.

Yet, despite all difficulties, 710 appointments were made from the start of the buildup to June, 1966, although the net increase to the workforce during this 12 months was only 386 persons, thus raising the total employment from 2,887 at the beginning of the year to 3,273. This pointed to a somewhat peculiar and rather unpleasant fact which was only cast in a clear light by the events of the next 12 months of the buildup.

During this period also the cupboard was bare, so to speak, in the area labor market and skilled workers or even experienced machine operators were virtually unavailable. The main reliance had to continue to be placed on the machine operators school to produce the necessary manpower. Through unremitting efforts, however, personnel officials succeeded in raising the level of the Arsenal workforce by 20%, that is, by a net of 633 persons to a total in June, 1967, of 3,886. Yet, in order to achieve this, 100 or more persons had to be hired each month, that is, two hirings

for each retention. There were numerous reasons for this "revolving door" employment problem such as at the WO-1 grade (lowest blue collar civil service rating) many of the newly hired were students who left to attend college when the time came, some were lost to the military draft and some proved unsuitable for other reasons. The composition of the work force at this time was 1,281 Class Act and 2,605 Wage Board employees. Of these, 3,170 were men and 716 were women. Most of these employees were of course, to be found in the Operations Division, where the rapid turnover of workers made difficult situations even more difficult. Division officials did point out, however, that it seemed they could expect more loyalty from new women employees than from men since the turnover among the former was only 36%, compared to 51% among the latter. In the face of these difficulties and with critical delivery schedules to meet, division officials continued to use a large amount of overtime. In the 12-months ending in June, 1967, an amount of overtime was used which provided an increase of approximately 20% in production hours. This meant that sometimes as many as 1,000 people continued to work six-day weeks.

The use of very large numbers of really untrained people during these two years of the buildup (July, 1965, through June, 1967) had its effect in other areas. In the Operations Division, efficiency, percentage of scrap repair and rework suffered slightly but in the area of work safety the effects were somewhat more serious. For the fiscal year ending in June, 1966, the lost time accident rate for the Arsenal was 0.34 million man-hours of work but in the next 12 months, as the influx of the unskilled workers began to be felt in the shops, there were 13 lost-time accidents. The accident frequency rate rose to 1.8 per million man-hours of work, more than five times the rate of the previous 12 months. First-aid injuries totalled more than 1,000 during this

same period. The Safety Office staff made every effort to curb these trends but pointed to the difficulty in making any inroads into them when the causes of the accidents were not anything exotic or unusual but rather the simple inexperience of the hundreds of new workers. In some areas bi-weekly safety inspections were conducted by the general foreman and either the safety officer or the chief of the Manufacturing Branch. Yet, while these high rates were unfortunate in human terms and alarming by Arsenal standards, it was pointed out that they were less than one-third of the accident rates considered acceptable by other industries in New York State.

In February, 1967, the membership of AFGE Lodge 2352, AFL-CIO, after many months of negotiation and one rejected contract, finally voted 760-60 to ratify an agreement with the management of Watervliet Arsenal. Mr. Paul J. Hayes, then president of the union, signed for his organization and Mr. Fred J. Clas, chief of the Arsenal's largest employing unit, the Operations Division, signed for the Arsenal. The agreement was notable in two respects since it was the first negotiated between the Army and the burgeoning AFGE in industrial northeastern New York State and it was the first such federal labor management encounter to employ the services of the Federal Mediation and Conciliation Service to resolve several impasses. The agreement followed closely the policies outlined in President Kennedy's federal employees labor relations executive order, applying them to the Arsenal labor management situation, and placing emphasis on these major areas. It provided a new and separate grievance procedure; it established a permanent union-management committee with equal representation for each party; it called for consideration to be given to seniority in the arrangement of vacation schedules; uniform application of sick leave and annual leave; recognition of seniority in assignment of parking places; the assign-

TREATMENT PLANT — Ground is broken for the waste treatment facility.

ment of overtime with some consideration to be given to the employees preference; a more comprehensive promotion plan and provision for recourse to the services of the Federal Mediation and Conciliation Service when impasses should be reached in discussions. On the other hand the union promised full cooperation and assistance to management in the implementation of management policies. Two very prominent aspects of union-management relations generally were absent from these proceedings however; there was no provision for compulsory arbitration and there was a positive prohibition against striking.

In May, 1967, the first major new building construction at Watervliet Arsenal since Bldg. 44 (the Gage Building) was erected several years before. The work of building an industrial waste disposal system, and installing new storm sewers was undertaken at a cost of $1.7 million with the work to be completed in 16 months.

The project began in late 1964 with a study of the Arsenal's industrial waste disposal system, or rather lack of it, by an environmental engineering expert. From his findings evolved plans for a waste disposal system which would make the Arsenal one of the leaders in the growing private and governmental effort to reclaim the polluted waters of the Hudson-Mohawk River system. The Department of Defense quickly gave approval for the Corps of Engineers to proceed with the actual design of the system and the project then began its long and danger filled journey to realization. In the summer of 1965, the project, having survived many intervening reviews, reached the House of Representatives as an item in that year's military appropriations bill and as such was submitted to the scrutiny of the House Armed Services Committee and three other committees before being voted upon. By early August, the bill had passed the tests of Congress and as part of the greatly augmented military bill (including the Viet Nam buildup special appropriations) it went to the White House for the signature of President Lyndon B. Johnson. The President signed the bill toward the end of September, but whatever jubilation installation planners may have felt at their success in acquiring funds for a new building (no easy task in the military system) must have been quickly deflated when, in December, Secretary of Defense Robert S. McNamara indefinitely postponed projects valued at $620 million — including the Arsenal's waste treatment plant. The reason, of course, was the critical diversion of manpower and resources to the needs of the fighting men in Southeast Asia.

Nevertheless, the release of the funds in February, letting of the contract shortly afterwards and the start of construction were all most welcome, if somewhat delayed. The site chosen for the building lay just south of Bldg. 38, the Iron Building, and the plant was designed to

handle a flow of 35,000 gallons of acids, oils and coolants per day with a provision for temporary overflow. These fluids would be neutralized in the disposal plant before being discharged into the river. Insoluble oils or other matter would be drawn off for disposal by other means, not dumped into the river. Other improvements of the Arsenal facilities were the completion, in the middle of 1967, of the second major phase of the rehabilitation of the Big Gun Shop, Bldg. 110, and the considerably expanded physical sciences laboratories in buildings 120 and 124. These projects also were major efforts and costs ran into millions of dollars.

Another interesting facet to the management of the Arsenal plant at this time was the addition of responsibility for a family housing complex at the recently deactivated Schenectady Army Depot. The 52 units of family housing were all occupied by military personnel and dependents, so that along with the number of military staff and dependents living on post at the Arsenal, the Arsenal's facilities officials became the "landlords" for quite a number of people. The closing of the Schenectady Depot also had the effect of returning to Watervliet Arsenal, at least for administrative purposes, an active Ordnance Detachment, the 146th Ordnance Detachment (ED) of two officers and nine enlisted men. The last such unit to have been stationed at the arsenal had been transferred to Aberdeen Proving Ground just before World War II.

Yet, while no soldiers other than the assigned staff officers were stationed at Watervliet Arsenal, uniforms were a common sight as hundreds of soldiers came to the installation each month to take advantage of its designation as an area military administrative center. These military visitors were mostly on leave and had come to be paid, receive or request changes in travel orders, etc., or not infrequently to receive help and advice in solving personal problems. Another, less pleasant duty, usually performed by the Arsenal's

staff military officers, was that of awarding medals, citations or other honors to the parents or relative of men who had fallen in Viet Nam. These were either taken in person to the residence of the family or presented formally in a brief ceremony in the Arsenal, according to the preference of the relatives.

Although the two years of intense activity of the SEA buildup from June, 1965, to June, 1967, centered most of the Arsenal's attention, energy and funds in the areas of operations and procurement, two remarkable advances in engineering processes were recorded in the period, significant enough to be called breakthroughs. The second phase of the first advance was completed in March of 1967 when the Army began testing a process for use in combat helicopters in Viet Nam which had been invented by an Arsenal scientist. Known as titanium hardcoating, the process consisted of anodizing the surface of titanium components so as to eliminate the tendency of the material to "bind" or "gall" when used in contact with another titanium surface. This tendency in the material had severely limited its use and had frustrated the hopes not only of ordnance designers but many other industrial users to gain the great advantages the material offered in high strength to light weight etc. When the Arsenal announced the solution to these problems at the end of 1964, almost immediately, a steady stream of interested representatives of business and industry began arriving at the Arsenal gate. Both the United States Air Force and private aircraft manufacturers were especially interested. The process was under steady investigation for the next two years which brought another considerable step forward when the titanium's anodized surface was successfully coated with an elastomer, an energy absorbent material. At this time the process was called upon to help solve a serious battlefield problem in Viet Nam where the helicopters, the ubiquitous workhorses of that conflict, had been experiencing severe

VIETNAM — Two arsenalites check wear on gun tubes in Vietnam.

wear and premature failures on account of the sand and other debris ingested by their engines when they were being operated from unimproved landing areas. It was felt that by coating important surfaces of the helicopter motors with the improved titanium process the abrasive and destructive effect of the sand and other material could be defeated.

The other most successful process achieved its climatic stage of development in early 1967 when Arsenal researchers successfully ex-

SAIGON—Arsenalite stands by 155mm Howitzer near Saigon.

truded four "high temperature" alloys at room temperature instead of the usual temperature of 2,000-2,400 degrees Fahrenheit at which this was done. A major advance, this was, however, not all that had been achieved: It was found that in some cases the yield strength of the material had increased 50-80%. None of these alloys (Iconel 718, Udimet 630, Rene 41 and Inco 713C) had ever been extruded before they were put through the 250,000 psi. press designed by Arsenal engineers and build by a private contractor. This process was especially exciting since it offered the promise, when perfected, of making it possible to extrude finished shapes, perhaps major components.

Other Arsenal engineers and technicians participated more directly in the war in Southeast Asia. Early in 1967 some of these men volunteered to make the long journey from the Arsenal to the Republic of Viet Nam to assist in solving supply and maintenance problems for the troops in the field. While they served in nominally safe rear areas, they were, on account of the fluid, guerrilla nature of the combat, often in danger. One man's hotel quarters were blown up by an enemy rocket shortly after he had left them and on another occasion a supply depot where he was serving narrowly missed being attacked by a party of enemy troops. These civilian volunteers often went about their duties armed.

At the end of June, 1967, Watervliet Arsenal was accorded a national honor and recognition of its historic role in the development of the nation and its armed services. The United States Department of Interior through its agency for guarding the national heritage, the National Park Service, chose the Arsenal for inclusion in the Registry of National Historic Landmarks. The Commanding Officers' Residence, the Big Gun Shop, the Old Barracks, and the Iron Building were singled out as unique and important features of the Arsenal's heritage.

Not long after, in Au-

gust, the people of the Arsenal received another agreeable piece of news when word was received that Colonel Kornet had been chosen for promotion to the rank of Brigadier General and would shortly receive a new position of great responsibility. He was the first Arsenal commander to be promoted to general officer rank since General Gillespie during World War II. It was announced that effective in mid-September, Colonel Kornet would be assigned to the Pentagon in the post of special assistant for munitions to the deputy chief of staff for logistics. The chief responsibility of the new job lay in planning and funding for all types of ammunition used in ground weapon systems. Lt. Col. Martin A. Shadday, the Arsenal deputy commander assumed the responsibilities of commanding the post during the brief period before the new commanding officer arrived.

Colonel Kornet, who had taken command at the moment when events called forth a burgeoning of defense activity and had overseen many months of operations conducted under tight time schedules, in the midst of the strains of reactivating lay-away production lines both in the Arsenal and private suppliers, conferred a parting accolade on Arsenal workers: "Never before have I worked with so highly trained and highly motivated a group of people."

Col. Arthur H. Sweeney, Jr., the thirty-eighth commanding officer of Watervliet Arsenal, took command of the post on November 15, 1967, Colonel Sweeney had then completed 25 years of a varied and interesting military career. His position immediately before taking command of Watervliet Arsenal had been a difficult one as commanding officer of Springfield Armory, then in the final stages of its "phase out." A native of Charleston, West Virginia, Colonel Sweeney was a graduate of Massachusetts Institute of Technology, where he earned the Bachelor of Science degree in Chemical engineering and later graduated from

Harvard University where he was awarded the Master of Business Administration degree. He was, further, a graduate of the Army Command and General Staff College, the Ordnance School, the Strategic Intelligence School, the Army Language School and had received specialized industrial training at the great E. E. DuPont de Nemours Company center in Delaware.

Colonel Sweeney's impressive academic credentials, however, were acquired in the intervals between holding important commands in the United States and abroad. One of the most important positions he had held was as a participant in the industrial planning for the Army Ballistic Missile Agency at Redstone Arsenal, Huntsville, Alabama. In that capacity he had considerable responsibilities in the planning for and procurement of production quantities of Redstone and Jupiter ballistic missiles. Another interesting post, he had held was with the United States Department of State as an assistant military attache in Switzerland where he participated in various disarmament activities. Colonel Sweeney also brought to the Arsenal recent experience in the prime military pressure point of the contemporary world: Cochin China where he served as the ordnance officer of the United States Military Assistance Group in Cambodia.

Shortly before the arrival of Colonel Sweeney, Watervliet Arsenal and indeed the whole arsenal system were favored with the scrutiny of the prestigious Wall Street Journal whose despatch viewed in a mostly favorable light the efforts being made in favor of national defense by government installations and employees. The report might have served as an informative and impartial precis of the Arsenal status quo for the new commanding officer. It pointed out that in the current fiscal year (FY-68) the Arsenal planned to spend $150 million, more than triple the amount spent in Fiscal Year 1966 (June, 1965 to June, 1966) and that production had

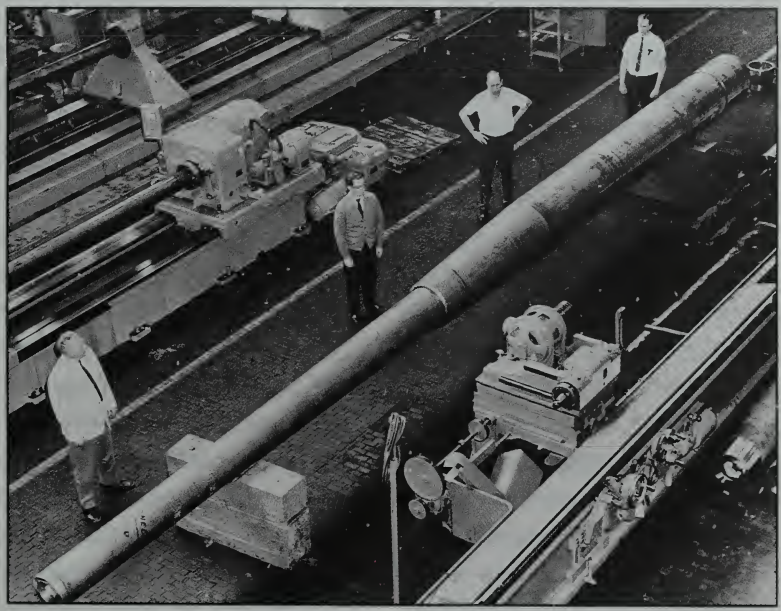
doubled in the past two years. The employment level had reached 4,000 persons but it was still proving impossible to obtain skilled labor. Henry J. DeCelle, the Arsenal official in charge of national procurement, again pointed to the curious situation presented by a thriving civilian economy competing with defense industries for manpower and resources at the same time that the United States was prosecuting a considerable foreign war. He pointed out that private industries were replying slowly or not at all to government invitations to bid on work. This and the difficulty of obtaining trained workers were but two of the problems, he said, which arose from the attempt to conduct wartime operations in the midst of a never anticipated "business as usual economy." Mr. DeCelle, a veteran of both the World War II and Korean War procurement struggles, was confident nevertheless that the Arsenal could do all that was asked of it and more.

The Arsenal's own efforts to improve manufacturing efficiency, perhaps to help take up some of the slack left by the sluggish response of industry to the needs of the time, had been greatly advanced in late 1966 and the first half of 1967 when $3.77 million had been spent on improved machine-tools. This equipment went to replace some items which had been on hand since World War II. In some cases, it was estimated one of the new machines would do the work of two or three of the old.

As the new fiscal year (FY-68, July, 1967, through June, 1968) progressed some favorable stabilizing trends seemed to be developing. In the Operations Division, despite the large number of trainees being fed into the system, the net efficiency improved slightly, the costs of scrap, repair and rework dropped to only 1% (the first favorable trend in this area in more than a year) and machine-tool maintenance downtime was decreased considerably. Otherwise, however, the handicaps under which Arsenal operations

were being carried out continued to have their effect, e.g., the employment situation was little improved with about 1,100 new hires and about 800 losses for a net gain of only about 300 workers for the 12 month period. The procurement and manufacturing emphasis continued to fall upon heavy weapons and a single order for 175mm. Guns in February, 1968, totalled almost $7 million.

One of these weapons found its way into an unusual place—the main battery of a fleet cruiser—and served to highlight the Arsenal's part in the seagoing war against the enemy in Viet Nam. That particular gun was wanted to give the naval support vessel the capability of long range high angle fire, since naval guns were usually designed for relatively flat trajectories. Two other Arsenal guns, although built for the Navy, performed the duty of shore bombardment most efficiently, indeed they were



8-INCH NAVY GUN — Orders arrived in 1968 for production of 5-inch and 8-inch naval guns.

veterans at it. These guns were two of the nine 16-inch guns in the main battery of the U.S.S. New Jersey, the only active battleship in the world, which had been reactivated and sent to Viet Nam to provide the very long range, overwhelming and accurate fire for which these weapons were famous. More routinely, however, the Arsenal accepted a $3.3 million order in June, 1968, to manufacture 5-inch and 8-inch naval guns.

As the spring of 1968 blended into summer, the war in Vietnam continued on an ever larger and more intense scale than before, demanding a steady supply of heavy conventional weapons to the battlefields and therefore continuing Watervliet Arsenal in its heavy responsibility as the supplier of these weapons. But with employment reaching about 4,150 at the end of June, 1968, (the change of status for 1,000 workers from "temporary" to "term" provided more benefits and promised to help stabilize hiring) and with favorable trends in manufacturing efficiency and improved equipment, it was a responsibility the people of the Arsenal could accept with pride and confidence for as long as circumstances should conspire to make it necessary.

In August, Colonel Sweeney, who had commanded the Arsenal during the peak of its Vietnam activity, left Watervliet for Rock island, Illinois. Not long before, he had been selected for promotion to brigadier general. His new assignment was deputy commanding officer of the U.S. Army Weapons Command headquartered at Rock Island.

Colonel William Mulheron, Jr., Col. Sweeney's successor, took command of the Arsenal a few months later. The installation's thirty-ninth commander, he was no stranger to the Watervliet area, having grown up in the nearby city of Schenectady, where his father had been employed by the General Electric Company. Previous to his Watervliet assignment, Col. Mulheron had been deputy program manager for

the United States-Federal Republic of Germany Main Battle Tank-70 Project. A native of Chester, Pennsylvania, he was a graduate of Rutgers University and held a degree in mechanical engineering. He also held a master of business administration degree from the University of Chicago. During his earlier military career, Col. Mulheron had earned seven battle stars in the Mediterranean theater during World War II, and had held ordnance assignments in Washington, Europe, Turkey and Korea. He was a graduate of the Army Command and General Staff College and the Army War College.

Also in the late summer of 1968, not long after Colonel Sweeney departed, two Arsenal technicians, Mr. Frederick W. Watt and Mr. Philip C. Fitzsimmons, left for Vietnam to work with the American and Vietnamese Armies. It was a further indication of the Arsenal's vital connection with the events taking place in Southeast Asia.

Only a comparatively few Arsenal people ever actually visited the battle zone. For the great majority of employees whose work in support of the armed forces was performed at the Arsenal itself, it was a source of pride when, in the fall of 1968, the installation's comptroller, Mr. Paul Hasselgren, was awarded the Army's Meritorious Civilian Service Award. Mr. Hasselgren received the award for his administration of Arsenal financial affairs during the Vietnam crisis and for his leadership in applying the Army Industrial Fund (AIF) accounting system to the Arsenal's fiscal management. Not long after, Arsenal officials were informed that Watervliet's modern, computerized accounting system was the first within the Department of Defense to be accepted by the Comptroller General.

Late in 1968, Watervliet Arsenal received another honor, this time in recognition of its many decades of support to the nation's armed forces when the Department of the Army authorized establishment of the Watervliet

Arsenal Museum of Ordnance. Arsenal people, proud of their heritage, had long wanted to establish a museum and welcomed the new development with enthusiasm. Many rare antique cannon — trophies of the Revolution, the War of 1812, the Mexican War, the Civil War, the Philippine insurrection and other conflicts — were gathered from various locations around the post and displayed in the new museum, appropriately located in the historic Iron Building. Arsenal employees donated time and labor to build the displays and the museum soon became a popular visiting place for school children studying their country's history and for serious students interested in the history of military weaponry.

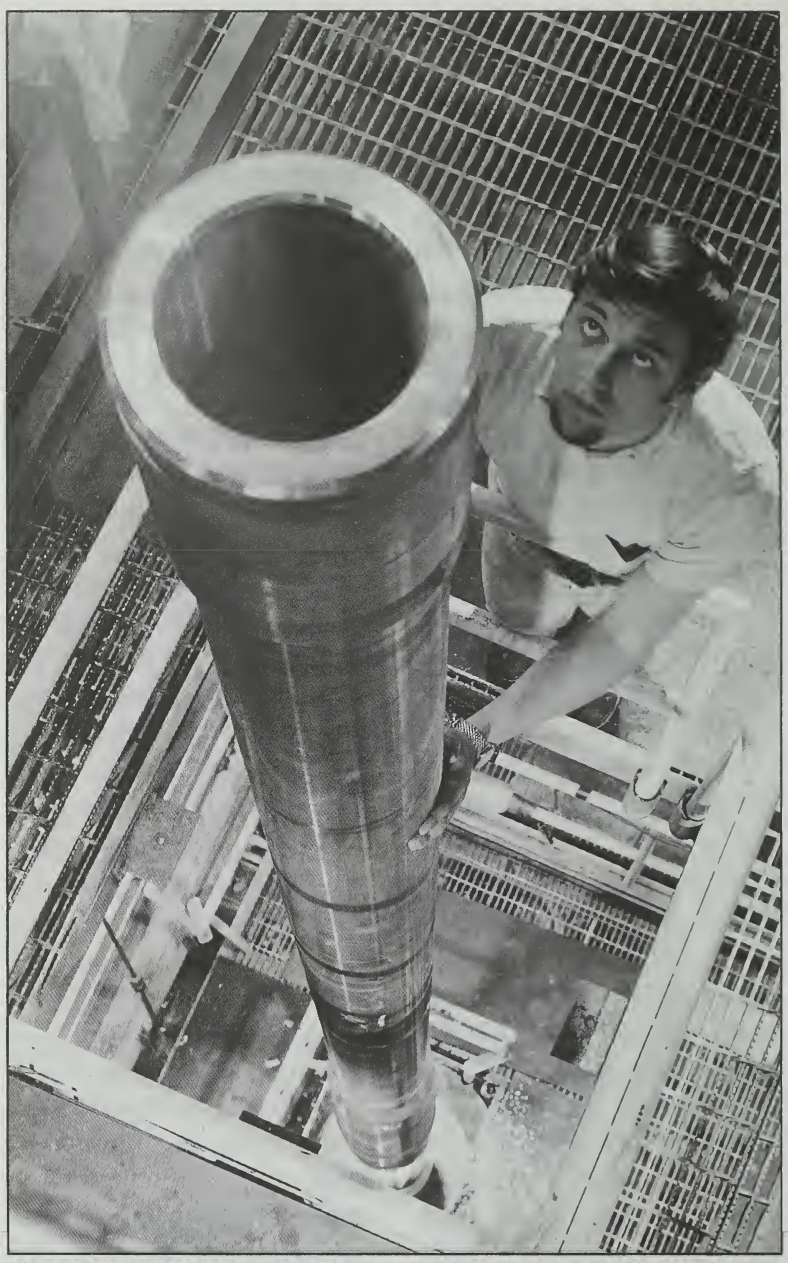
Arsenal weapons production continued at a high level (although its total volume fell a little) into 1969 with concentration on heavy weapons. For example, 369 175mm guns, 978 spare barrel assemblies, and 176 8-inch howitzers were manufactured by June 1969. Most of the arsenal's weapons and non-mission items were for direct use in Vietnam and there were 28 more urgent "Red Ball" orders for the battle zone, handled on a priority basis. In the midst of these pressures, the Arsenal recalled a bit of its technological know-how that had not been used in more than 20 years when it shrank the barrel on to the liner of an 8-inch Mark 15 gun for the Navy. This task served as a reminder of the professional versatility to be found at the Arsenal and a further example of what one of its commanders later called its "institutional memory."

The real highlight of 1969, however, represented not only a technological feat but also the solution to a battlefield problem and a source of great monetary savings to the government. This event was the presentation of the Department of Defense Certificate of Merit to Col. Mulheron by Vice President Spiro T. Agnew in a Pentagon ceremony. The award recognized the Arsenal for achieving the greatest sav-

ings of any DoD installation that year. The savings totalled more than $24 million, of which $21 million represented the Benet Weapons Laboratory's successful campaign to triple the firing life of the 175mm gun through autofrettage.

The failure of a 175mm gun earlier during the Vietnam conflict had raised a previously unforeseen problem that demanded immediate attention: a dramatic loss of fire power brought on by a modification in the steel used to produce gun tubes. Historically, guns had always worn out — that is, lost their accuracy — long before their "fatigue life" breaking point had been reached. However, the drive to achieve longer ranges in modern artillery meant firing at higher and higher pressures which, in turn, required a modification of the steel used in gun tubes. An unlooked for side effect of this modification was the loss of some of the fundamental quality of the steel known as "toughness." Guns made of this modified steel had failed, with the result that the rated firing life of 1,200 rounds had to be reduced to 300 for safety. This meant that the Arsenal would have to produce many more 175's to achieve the necessary fire power on the battlefield.

The solution arrived at was an operation known as "autofrettage" — a process whereby a permanent prestress is introduced into the gun tube during manufacturing. By applying internal pressures of approximately 100,000 pounds per square inch to the walls of the tube, Benet scientists found they could achieve a higher yield stress without markedly reducing the original toughness of the steel. Fatigue tests on autofrettaged tubes showed a dramatic increase in fatigue life that restored the designed safe firing life of the 175mm to 1,200 full charge rounds. The first-year savings of $21 million that resulted from the introduction of autofrettage to the Arsenal's manufacturing operations more than doubled over the next decade. The new firing life of the autofrettaged 175's was



AUTOFRETTAGE — A 175mm gun tube is lowered in hydraulic autofrettage pit.

proved by firing a dozen of the guns from five fire bases in Vietnam's Central Highlands, thus saving additional millions of dollars that would otherwise have been spent test firing the guns at proof ranges.

The successful 175mm gun autofrettage program was by no means the only Benet activity worthy of note during the waning years of the Vietnam war. Indicative of the overall stature of Benet's research and engineering activities during this time was the appointment of Benet's technical director, Dr. Robert E. Weigle, to the Army Research Council. The council, which was made up of prominent scientists, engineers and research executives, advised Army leaders on research programs worth more than $200 million a year. Further, Dr. Weigle became a member of the Department of Defense Joint Discussion Forum, which met quarterly to discuss the activities of all the armed services.

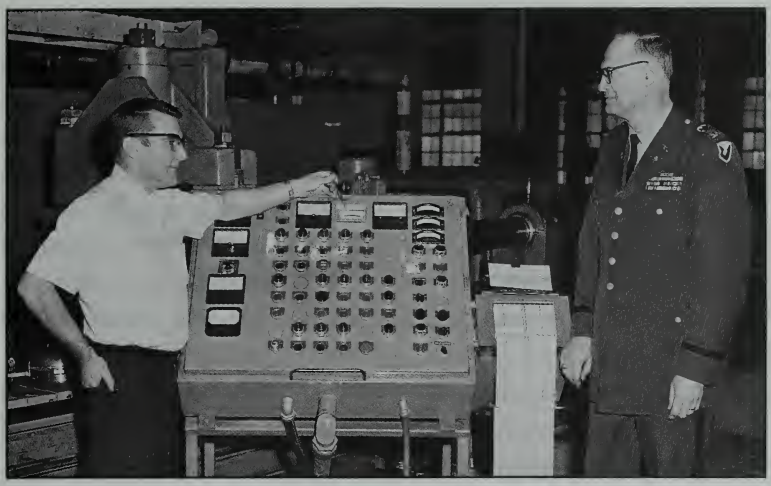
Research activities received a new impetus in early 1969 when 50 Benet scientists, engineers and technicians moved into modern quarters in Building 120. The building was equipped for work in experimental mechanics and thermodynamics, and Maggs laboratories were expanded with facilities for solid state physics, electrochemistry and physical chemistry. By mid-1973 the Arsenal's Facilities Engineering Directorate had completed its long-range work on Building's 120 and 115 to allow the concentration of Benet's research activities in these two buildings.

Work in these fields did not go without notice in the large arena of Army-wide research activities. In May of 1969, a team of three Benet researchers won the Army Research and Development Achievement Award for their work on the theory of the mechanics of solids; two years later a group of five Benet scientists won the same high-level award for their investigations into the fracture mechanics problems in thick-walled cylinders. It was noted

that their work had application not only to weapons but to industrial materials as well.

During these years, Benet personnel continued working to improve heavy arms in the current inventory and to bring forward the next generation of weapons to meet future requirements. Some of their lesser projects were also worthy of note, such as the design and manufacture of a shoulder-fired doughnut-shaped launcher for the "ring airfoil grenade," a fiberglas filament-wound shroud for gun tubes to cut down on thermal droop and thus improve accuracy, and a fiberglas one-shot 81mm recoilless rifle launcher used to fire rockets against tanks and bunkers.

The years before the end of the Vietnam war were especially fruitful in manufacturing technology. Indeed, one invention by a Benet engineer was hailed as the most significant new process to be introduced into gun-making in more than three decades. This was the development of "guided-boring" by Mr. William Wondisford. Guided-boring, which had been in-progress for four years and reached full acceptance in 1973, consisted of the integration of boring head and cutting tools with electronic sensors. These sensors were able to detect and instantly correct any deviation or eccentricity in the programmed straight path of the cutting tools and boring head as they cut the bore down the length of the gun tube forging. The result was the unprecedented ability to bore a hole down the interior of a 36-foot long forging of super tough steel with a deviation from absolute straightness of no more than five thousandths of an inch — equivalent to the thickness of a razor blade. The development of a method of performing the single most difficult task in gun-making — machining the straightest possible bore — was a great success for Watervliet Arsenal. The beneficial results of the process were immediate and widespread. Typically, only one pass of the head through the forging was now necessary, rather than the several passes previously re-



GUIDED BORING — Automated guided boring, developed at the arsenal, has become an essential in modern gunmaking.

quired — a reduction in machining time from 28 to 8 hours — and, because of the method's near-perfect accuracy, other manufacturing steps were eliminated entirely.

First applied to the 175mm gun, guided boring soon became essential in the manufacture of all the Arsenal's major weapons. Four years later, when the guided boring system had proven itself many times over, Mr. Wondisford was recognized for his achievement when he was presented with the Secretary of the Army's Award for Outstanding Achievement in Material Acquisition. By then the new method had saved the Army many millions of dollars and Army experts acknowledged that Mr. Wondisford's process had advanced the state-of-the-art in this area of artillery manufacture by several years. Outstanding as this development was, there were other significant advances in manufacturing technology during this time. Among them was the use of refrigerated cooling liquid under pressure to greatly speed the tube boring operation, and a great improvement in cutting the threads on the breech rings

of 175mm guns and 8-inch howitzers. The latter improvement shortened the machining time required from 12 hours to two. These manufacturing technology advances, and others, were the result of close cooperation over a period of several years between the Operations Directorate — the manufacturing organization — the Benet Weapons Laboratory, as designer and developer, and the Procurement Directorate, which "justified" the projects to higher Army organizations and obtained the money to finance them.

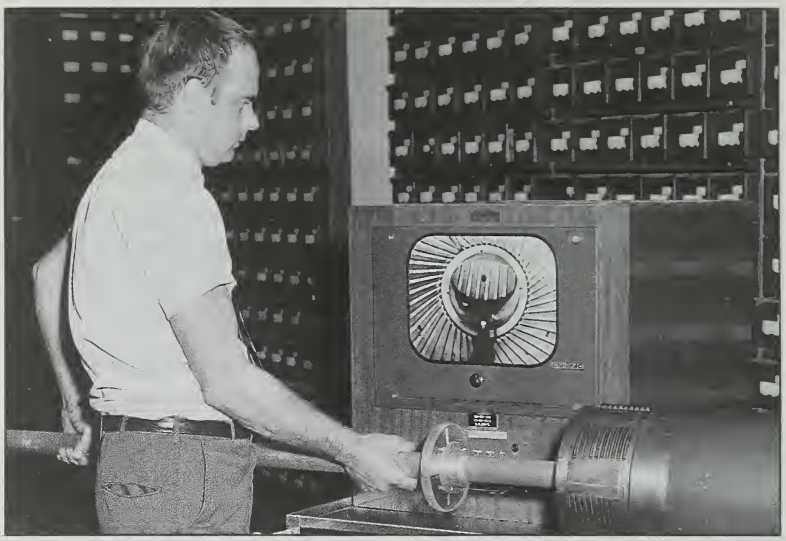
Proof of the good use to which the Operations Directorate put these and earlier manufacturing developments came in mid-summer 1969 when Secretary of the Army Stanley Resor awarded the Department of the Army Decoration for Exceptional Civilian Service to Mr. Fred Clas, chief of the Operations Directorate, for his guidance of the Arsenal's production organization during the hectic early years of the Vietnam war. During these years, workload had increased by 120 percent and 1,500 unskilled workers had been trained up to meet the Arsenal's exacting standards. Despite these difficulties, Mr. Clas' operation had achieved an on-time delivery record of 98.3 percent, even under conditions of highly-compressed delivery schedules.

While mid-1969 thus brought recognition to one of the Arsenal's oldest organizations for its good work during a crisis, it also marked the establishment of a new organization designed to assure fair treatment of all Arsenal workers and their working environment. Col. Mulheron announced that the newly founded Equal Employment Opportunity (EEO) Office would administer the Arsenal's share of the federal government's Equal Employment Program, including the Federal Women's Program. The EEO Office at the Arsenal would in future years provide not only a ready forum for redressing the grievances of minority employees, including women, who felt they had been unfairly treated in some aspect of their employ-

ment, but it would also prove a source of positive education to curtail similar difficulties in the future. An early product of the new office was a favorable report to the effect that while only 10 percent of the Arsenal's workforce were women, this small segment was well represented in positions of responsibility in the shops and the Arsenal's administrative and support organizations. Women held positions as legal advisers, procurement contracting officers, technicians, engineers and physicists and were well represented in the laboratories and health services.

As the demands of the battlefield required more powerful and longer-range artillery weapons, Arsenal designers were faced with the difficulty of designing cannon that could be fired at higher pressure to meet these requirements. Unforeseen difficulties arose from this, as with the 175mm gun and again autofrettage proved to be the most immediate solution. Even with autofrettage, however, extensive live ammunition proof firing was required — a very expensive matter — in order to satisfy the safety requirements of the field. Yet firing-to-failure in order to develop gun strength data as a basis for future designs seemed economically impossible.

One successful interim solution was devised early in 1970. In this case, barrels for the Army's standard M14 infantry rifle were manufactured of the same steel as that used in artillery weapons, according to a plan of the Arsenal's Quality Assurance organization. In this way, a round could be fired in these rifles and the same information could be obtained (for testing purposes) as if fired in a full-sized cannon. This allowed firing-to-failure tests to be conducted for an absorbable cost of about $9,500 per test, as opposed to a prohibitive $9 million if conducted with a real cannon. Statistical sampling to reduce the need for live ammunition proof firing also continued in these years and by 1970, 40 percent of the weapons usually test fired were accepted



BORESCOPE — Closed-circuit TV is used to examine bore of cannon tubes.

for field use with no test firing. Quality assurance techniques and equipment continued to improve with the design and introduction of a closed-circuit television system for inspecting cannon bores. This innovation was highly successful and was soon adopted by the Navy for use in its weapons facilities. Also developed was a system of air-pressure operated gauges able to measure internal diameters to five ten-thousandths of an inch. The television system was especially effective, since it allowed the picture of the inspected item to be magnified on the screen or monitor, and at the same time video-recorded for future reference.

Early in 1970 the new water pollution control plant was opened with ceremonies presided over by Col. Mulheron. The new facility made the Arsenal one of the first federal organizations in the country to comply with a presidential order to end pollution by government installations. With a treatment capacity of 6,000 gallons per hour and 59,000-gallon holding tanks, the treatment plant was able to render harmless

the liquid waste the Arsenal discharged into the Hudson River. In the next decade, another $3.5 million would be spent to improve liquid waste treatment and abate air pollution.

This project was managed by Facilities Engineering, which also concluded another major project the following year. This work considerably altered the physical appearance of the Arsenal by eliminating its riverfront parking lot, which formerly served as the Hudson River shipping wharf, and an adjacent portion of wall, heavily constructed of limestone blocks, which had served the Arsenal for most of the 19th Century. Thus, a relic of the historic river transportation system (one of the main reasons the Arsenal was placed at Watervliet in 1813) yielded to a modern transportation system when New York State built a multi-lane high-speed highway along the riverfront. The Arsenal was compensated by being given a small amount of new land along its south-east corner where a new gate was built in 1971.

Urgent special orders for the Vietnam battlefields continued through 1970, but the level of mission workload declined sharply as hostilities in Southeast Asia levelled off through the second half of 1969 and into 1970 and finally bottomed out in July. Reductions-in-force (RIF's) in December 1969 and May 1970, together with attrition, had cut total employment to 2,650 by June 1970, a drop of more than 1,300 from the level of 12 months before. Officials pointed out that most of the employees lost in the 1969 RIF were temporary appointees, but that the 1970 RIF had cut deeply into the permanent workforce and affected employees with many years of service because retention preference was given to veterans. The installation's largest employing unit, the Operations Directorate, lost 900 workers. Despite that drastic cutback, in June 1970 it appeared that there would be no work for about 15 percent of the direct labor people. The fact was that new orders received by the Arsenal had

declined by more than half from about $88 million in fiscal year 1969 to about $43 million in fiscal year 1970. All manufacturing operations were, in fact, carried out on one shift.

One Operations manager, commenting on the unpleasant and too-frequent phenomenon of reductions-in-force, noted that certain transitional periods usually existed before and after a RIF. The pre-RIF period was characterized by a serious morale problem with a drop in the overall efficiency of the workforce. The post-RIF or recovery period was characterized by reassignments of personnel and the subsequent heavy retraining of employees on critical operations. During this adjustment period, efficiency rose slowly and finally stabilized at an acceptable level, marked by the completion of retraining. Fiscal year 1970 (July 1969-June 1970), an official said, was the most turbulent and demanding period experienced by Operations in a decade.

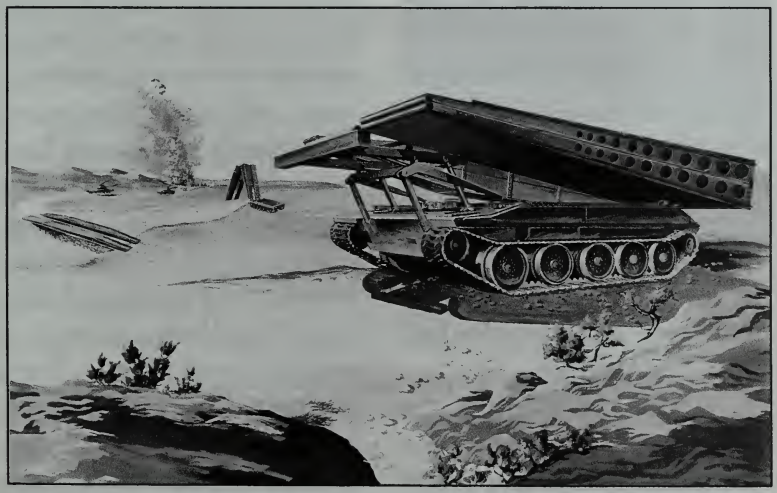
Drawing on past experience, the Arsenal responded to the drop in workload by recalling to the Arsenal some of the work that was being done in private industry — some 90mm and 105mm tank guns, two types of 105mm howitzers and the 106mm recoilless rifle. By December 1970 all contracts with private suppliers of these weapons — Firestone, Hughes Tool, Remco, Lockheed, Bouligny, and Milo — were terminated and Watervliet Arsenal was once more the only active source of cannon for the armed forces in the whole country.

A vital source of work for the installation remained, as before, solicitation of support-mission contracts. For three years — from 1969 to 1972 — Arsenal officials sought out work wherever they could find it. The Weapons Command, all the Army Materiel Command(AMC) commodity organizations, the Air Force, Navy and Marine Corps were visited with urgency and regularly by work solicitors — in all more than 300 visits were made. The result was a steady

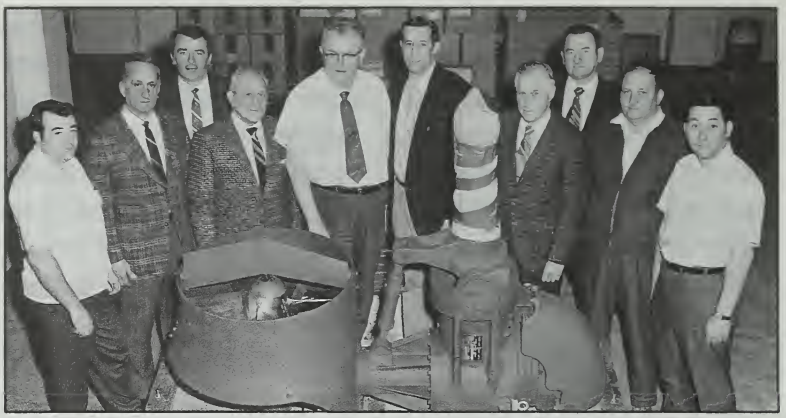
but mixed series of orders. The Arsenal produced grenade launchers, helicopter parts, marine drive assemblies (like huge outboard motors), a new type of portable scissors bridge, ammunition storage units, tank air filters, and many more items for a mixed bag of military hardware.

The orders were very welcome but handling them satisfactorily presented special difficulties. One official noted in 1971 that these many small-lot production runs, with short lead times, required a workforce flexible enough to be frequently moved to new work areas and still perform in an efficient manner. But the flexibility and the experience were available, and, through very careful labor and financial controls, the Arsenal was able to keep down its prices to customers and compete successfully for the work it needed.

A total of 155 support-mission work orders worth more than $21 million were obtained, but Arsenal officials achieved their greatest success in support-mission solicitation in 1972 when they obtained a nearly $5 million



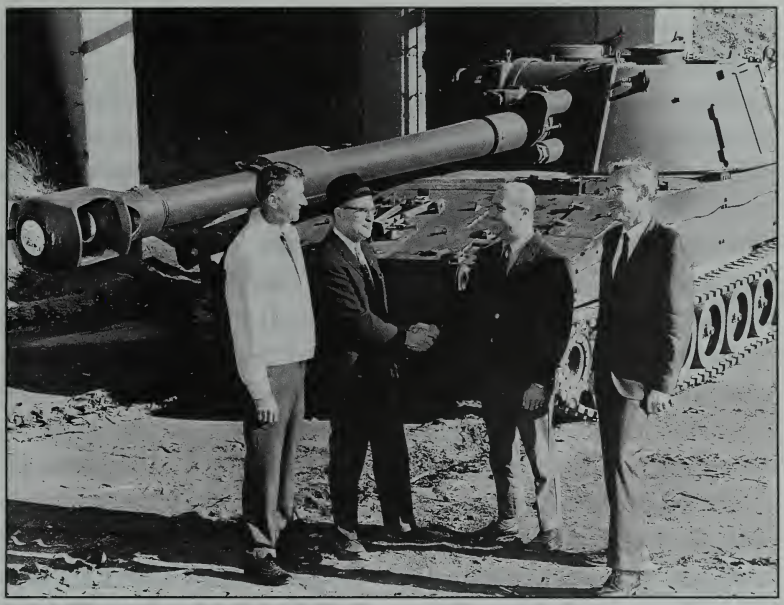
SCISSORS BRIDGE — Among support mission work made at the arsenal was a new type of portable scissors bridge.



MARINE DEVICE — Other support work included marine drive assemblies, like large outboard motors.

order for production of M109A1 modification kits. In terms of dollar value and labor it was the largest support-mission order the Arsenal had received to date and it brought the total of such orders for that year up to about one-third of the total Arsenal workload. The MOD kit, as it was called, altered the recoil system of the M109 vehicle to allow installation of the 155mm XM 185, a much larger and heavier weapon than the recoil system had been designed for.

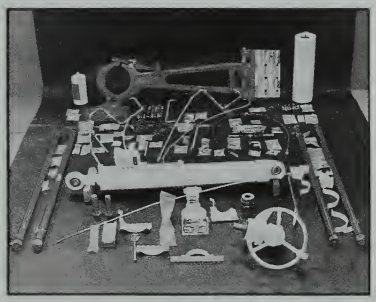
And in the middle of the struggle to keep the Arsenal's workload and employment level stable, a change of command took place. Colonel Mulheron retired from active service in the summer of 1971, and was replaced by Colonel Christopher S. Maggio, the Arsenal's fortieth commanding officer. Col. Maggio came to the Arsenal from the Pentagon where his specialization in the management and modernization of the Army's production base was an especially fitting preparation for his leadership at the Arsenal. The new commander was a native of Buffalo, New York, and held an engineering degree from Rutgers University and a master's degree in business administration from Syracuse University. He was also a graduate of the Army's Com-



MOD. 155MM — Final successful testing of new 155mm at Malta Test site is followed by congratulatory handshakes.

mand and General Staff College and the Armed Forces Staff College. A veteran of the World War II Pacific Theater campaigns. Col. Maggio had subsequently held many posts of responsibility in the United States and abroad, including a tour in Vietman.

It was the new commander's task to govern the Arsenal's affairs during the final phases of the Vietnam war. For, while the Arsenal's fortunes waxed and waned in regard to work and employment levels, the war in Indochina had continued unabated. And the bitter difference of opinion concerning it had continued in the United States. While one



MOD. KIT — Kit for modifying new 155mm gun.

protest resulted in some mild trouble at the Arsenal gate earlier in the war, two later demonstrations were peaceful: one in August 1968, when 30 people gathered at the Main Gate on Broadway to protest the anniversary of the bombings at Hiroshima and Nagasaki and the Vietnam hostilities, and the other, the last, in May 1972 when 40 college students gathered at the Main Gate to protest what they called the "escalation" of the Vietnam conflict. Private opinions of the war differed among Arsenal people, although the great majority strongly supported the policy of containment of Communist expansionism in Asia. But minds were not closed at the Arsenal-on one occasion a clergyman leader of the anti-war movement in the local area was invited to address the Arsenal Foremen's Association concerning his views. Still, whatever differences there may have been among individuals, there was never any question that the Arsenal overall was anything but fully and wholeheartedly committed to supporting our fighting forces in Southeast Asia.

While the armed conflict continued abroad, a kind of labor-management peace was achieved internally at the Arsenal. In October 1972 Col. Maggio signed for the Arsenal a two-year agreement with the American Federation of Government Employees (AFGE). The Arsenal's first labor-management agreement had been renewed annually since it was first signed in 1967 with the only notable changes being the inclusion, in 1970, of union representatives in area wage surveys and the beginning of an environmental pay plan. Under the latter, workers were entitled to extra pay for various physical hardships, difficult working conditions or hazards involved in their jobs. The 1972 agreement added a new streamlined procedure with binding arbitration and the formation of a union-management committee to work for a quick solution of complaints. Union-management relations were generally amicable, but inter-union relations were

sometimes strained. The National Association of Government Employees (NAGE), which represented only a very small number of Arsenal employees, challenged AFGE for the right to represent all workers in 1971 and was narrowly defeated. AFGE faced a second challenge by the rival union in the summer of 1973 and again survived by a slim margin of votes. The heated struggle for the right of representation, unfortunately, brought the Arsenal to the attention of national Army-related publications when the Arsenal's AFGE leadership charged that the installation's production efficiency had fallen and employee morale was low, in its opinion, because of management's attitude toward the union. The charges were firmly and accurately rebutted by the Arsenal's supervisors' organization. But NAGE finally won a designating election four years later, ending AFGE's 12 years as the Arsenal labor representative.

The persistent drive to bolster the Arsenal's vitality by acquiring support-mission work, which had begun in the last year of Col. Mulheron's tenure and continued through the first year of Col. Maggio's, had served its purpose: by mid-1973 the Arsenal workforce stabilized at 2,625 people, after having reached a low of about 2,400 two years before. Arsenal officials were able to record that, with a full workload of mission orders during fiscal year 1973 and with the same situation forecast for the next year, active solicitation of support-mission work would end. Now the installation would adopt the policy of taking only follow-on orders for material it had experience in producing or for items that "customers" could not obtain elsewhere.

Production of weapons had also stabilized at the lower level of employment and funding. Whereas almost 400 175mm guns had been produced in the 12 months ending June 1969, plus several hundred spare tubes, only 48 175's were manufactured in fiscal year 1973. Most other Arsenal

weapons conformed to this lower-production pace, although the 155mm howitzers for the M109 self-propelled system continued to be made in numbers.

Late in March 1973 the last American troops left Vietnam, bringing to a close the Army's and the Arsenal's nine-year engagement in Southeast Asia. But the end of the conflict had something of an air of anticlimax, for the focus of American grand strategy had already shifted to Central Europe. There, during the Vietnam years, the Communist Warsaw Pact nations had been building massive forces for armored warfare. This grave threat would require new weapons to counter it, and thus bring new responsibilities to Watervliet Arsenal.

Chapter 13

Modernization

The end of U.S. involvement in Vietnam in 1973 had little impact on activity at the Arsenal since work directly related to the war had already been declining for the previous two years. Within the scope of the peacetime manpower and funding levels at the Arsenal, emphasis was now placed on producing weapons in greater numbers and with greater firepower to counter the menace of the burgeoning armored forces deployed by the Communist nations in Central Europe. A key to the Arsenal's activity in this regard was the very heavy emphasis placed on production of 105mm M68 tank guns. It was to be an emphasis maintained for the next five years.

The 105mm M68 — a British-designed tube with an Arsenal-designed breech — had been in production at the Arsenal for several years as the principal armament for the Army's main battle tank, the M60. The nature of the Vietnam war, however, had offered little scope for modern armored warfare, and thus the demand for these 105's in Southeast Asia had not been great. The worsening Euro-

pean situation, however, led high Army authorities to decide to greatly increase M60 tank production as well as to re-arm M48 tanks (the tank that preceded the M60 and was armed with a 90mm gun) with 105's. The possibility of arming all or part of the next generation of tanks with the same weapon was also raised.

Arsenal production of M68's mounted from about 150 complete guns with a few hundred spare tubes during the 12 months ending in June 1973, to 1,853 guns and 1,340 spare tubes in fiscal year 1977. Meeting this heavy demand, which came in addition to regular orders for other weapons, placed a considerable strain on the management of Operations and Facilities. Extensive rearrangement of both breech mechanism and tube manufacturing lines was required, yet, Operations Director Fred J. Clas, was able to say at the peak of the program in 1977 that, despite the high production requirements and constantly changing M60 tank schedules, a 100 percent delivery performance had been maintained on every item in the program.

The summer of 1973 was also the time for a change of command with the arrival of the Arsenal's forty-first commanding officer, colonel Richard H. Sawyer, who, after Col. Maggio's retirement from active service, would preside over the first years of the Arsenal's rapid build-up of the tank gun program and other new programs. Col. Sawyer came to Watervliet from Washington, DC, where he had been chief of the International Division in the office of the Army Chief of Research and Development since June 1972. During his 23 years of military service, he had served two tours of duty in Korea, one in Germany and had also held posts with the U.S. Army Tank-Automotive Command and the U.S.-Federal Republic of Germany Main Battle Tank Development Program. Col. Sawyer was born in New York City and was a graduate of City College of New York. He held a master's degree in mechanical engineering from

Purdue University. Col. Sawyer was a graduate of the Army Command and General Staff College and the Industrial College of the Armed Forces.

The great expansion in the tank gun program was not the only feature of Colonel Sawyer's time in command in the years immediately following the close of the Vietnam war. During this period, sophisticated new concepts of management, automation of proven manufacturing methods and new production techniques which had been in germination for some time were introduced. These developments were the prelude to an extensive modernization program that was going to have a major impact on the Arsenal in the form of new buildings and equipment.

In December 1973 a new office was formally approved for Operations Directorate. The new organization, to be called the Operations Systems Office, was to make a concentrated effort to speed the application of computer science to production management, and to bring this use of computers at the Arsenal up to the state-of-the-art in the shortest possible time. The office was to specialize in the development and coordination of numerical-controlled and computer-aided manufacturing systems, while also assuming the responsibility for modernization of production planning and control systems — especially those having to do with shop scheduling and control, workload forecasting, cost estimating and control, acquisition of material, in-process inventory control and manpower control systems.

The establishment of the Operations Systems Office was followed by a progressive transition from the traditional role of computers in handling payroll and accounting functions to that of a manufacturing management information system. On-line computer systems were developed to project and simulate workload forecasts, and to automate bills of material representing mission items and produce computerized procurement documents and

specifications. Manufacturing cost estimates were also computed automatically for new work and for measuring performance on work in process. Also computerized were production routings for weapons components through the manufacturing areas to reflect the latest method and sequence of manufacturing, as well as the latest engineered time standards. With the computerization of industrial plant equipment data and available manpower it became possible to accurately plan production in relation to available resources.

The computerization of technical data on all standard mission items with regard to acquiring necessary castings and forgings, for example, was completed in 1974 and cut the usual lead time for developing this information by 50 percent. Other applications of computerization followed in the succeeding four years. But perhaps the most significant application of modern computer technology to weapons manufacturing came in 1978 with the installation of the automated "Source Data Collection system," known for short as SDC.

The design and development of this sophisticated production control reporting system was one of the first tasks of the Operations Systems Office after its permanent establishment in 1973. The new system consisted of a series of 42 remote electronic terminals located in the manufacturing areas. The direct passage of production information from the shops into computer data banks had several benefits. It eliminated time-consuming and error-prone manual and clerical operations such as keypunching; and made possible "realtime" validation and correction through the use of a mini-computer within the system that allowed errors to be caught and corrected when and where they happened before the information was entered into the data processing computer. Thus, information which formerly took more than a day to assimilate could now be handled in a matter of seconds. But be-

yond the greater speed and accuracy of acquiring this data, SDC meant that production information could rapidly be made available to all concerned levels of management to form a basis for efficient and cost-saving decisions.

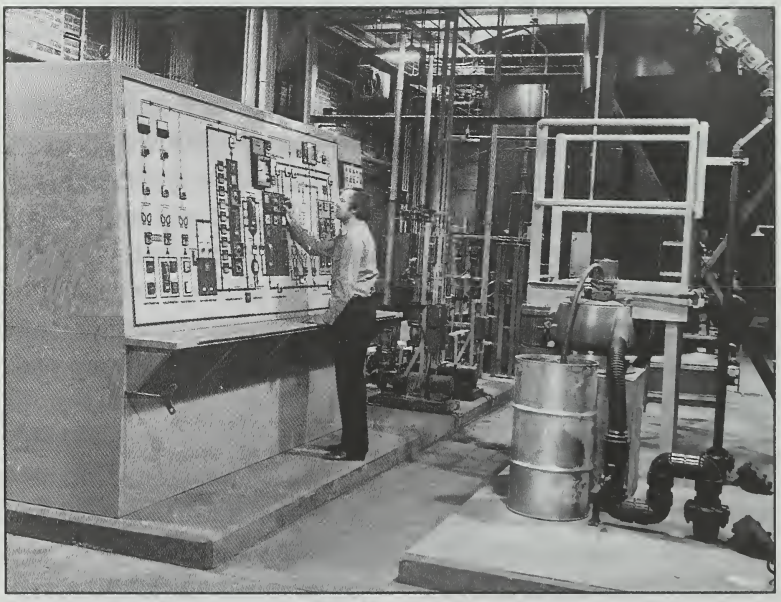
The system saved a considerable amount of money through greater efficiencies and through the elimination of a number of jobs concerned with no-longer-needed data handling functions. SDC also allowed for more accurate work accounting in areas that had been very difficult to manage before, for instance, when a worker was involved in a variety of operations intermittently, or when he was engaged on two or more projects simultaneously. The Source Data Collection System made it possible to apportion the value of such work much more accurately than before.

The expansion of the use of numerical control (NC) machines, that is, those that are controlled by a pre-programmed tape, continued throughout the mid-1970's. By 1977 there were 65 NC machines in use in the Arsenal shops making Watervliet Arsenal the largest user of this sophisticated equipment among Department of Defense government-owned-government-operated facilities.

While management and technological activities showed much advancement during these years, one Arsenal area was showing some difficulties by 1975. The safety program statistics showed an increase in the accident rate that was to continue through the next few years. Accident rates had actually shown a decreasing frequency between 1968 and 1971 and had remained generally stable between 1971 and 1975. Arsenal experts concluded that the period of decreased accidents was actually a beneficial spin-off of the heavy cutbacks of employees during that time, inasmuch as the RIF's tended to separate shorter-term workers, while leaving on the staff veteran employees with longer training in safety measures.

approval for a $1.7 million project to bring the Arsenal's cyanide treatment plant up to the state-of-the-art. The Arsenal's effort to meet its environmental responsibilities was recognized at this time when it was chosen as the subject of an intensive and comprehensive environmental impact study planned to serve Army-wide as the model for Army installations with production facilities and also the environmental model for Army engineering facilities.

Two significant building projects were undertaken during this time. Building 135, one of the Arsenal's major manufacturing buildings, had been constructed during World War II and no major renovations had been made to it since. In 1977, however, $2.2 million was approved to update the building's power and other facilities and to upgrade working conditions for employees by improving both the ventilation system and the personal facilities pro-



CYANIDE PLANT — A $1.7-million state-of-the-art cyanide treatment plant was built in 1976.

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At about the same time this project was approved, another major project was completed—construction of a 24,000-square-foot addition to Building 44, which housed the Product Assurance Directorate.

The expansion and renovation of Building 44 was needed in order to provide modern facilities for the Arsenal's expanding use of inspection and measurement equipment. Thus, the Calibration Laboratory was modified to provide temperature control of plus or minus one degree, to closely regulate humidity and, to filter the air to a completely dust-free state.

Product Assurance both modernized traditional inspection methods by developing a new lightweight borescope (the periscope-like optical instrument used to inspect the interiors of gun bores) and by making use of the most sophisticated new inspection techniques using ultrasonics, lasers and computer technology.

Ultrasonics of high-frequency sound waves were used to determine the thickness of various objects and to detect internal flaws. By passing inaudible sound waves through the object being inspected — such as a gun tube or a breech ring - the actual thickness of the material would be completed to the desired thickness automatically and this information immediately displayed on a digital readout. Sudden variations from normal thickness would locate internal cracks in the component. Moreover, the equipment could be used to inspect a wide variety of materials, including plastics and composites. Another model of the Arsenal's ultrasonics equipment could be used to inspect hot materials, such as gun forgings, at temperatures up to 2,000 degrees Fahrenheit.

Laser technology was also enlisted in the effort to provide a quicker and more accurate means of locating flaws or cracks in gun component interiors. This method of laser scanning, developed and applied to weapons technology, involved sending an

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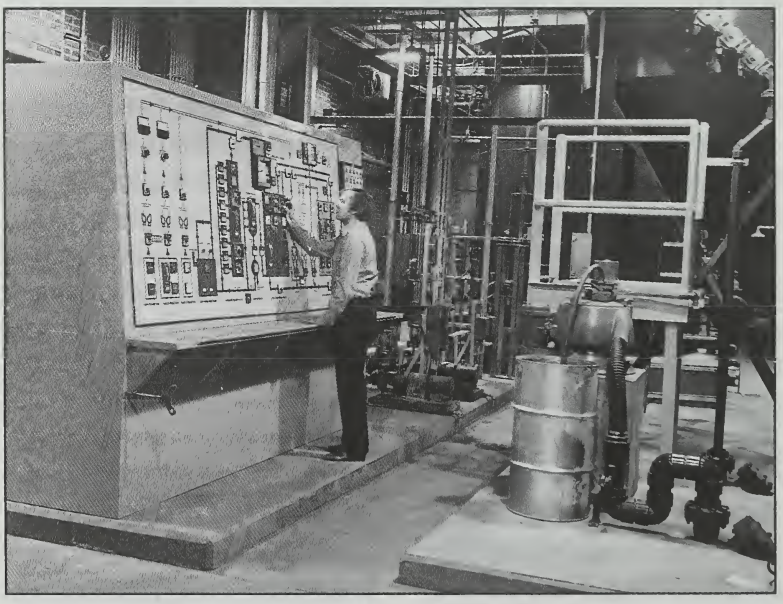

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instrument package consisting of a near-ultraviolet laser light generator and associated light-sending devices through a gun bore. The laser light would be projected on the interior of the gun bore and the reflected light received by the sensors. Any difference between the projected light and that reflected onto the sensors would show on an automatic print-out of the inspection information, as would the shape of the flaw.

Electronic sensors were used in the gun tube inspection machine to compare information about the bore and rifling grooves with the design criteria for these features. A pre-programmed rifling twist measuring system was also developed, again using electronics to locate and record problems with rifling.

Another device developed to serve the Arsenal's continuing requirements for precise measurements was the laser interferometer calibration system. Also a pre-programmed device, it was designed to take advantage of the laser's ability to maintain straightness over long lengths. The Arsenal's equipment was able to measure straightness to three-millionths of an inch. The inspection information this system produced was shown immediately as a graphic display on a digital readout, or the information could be stored on tape for later examination. This precise system was used to measure long-length standards, to calibrate numerically-controlled machine tools, coordinate-measuring machines, rifling machines, and to calibrate flatness measuring devices, as well as height gauges, micrometers, encoders and other precision measuring instruments.

The use of minicomputers and microprocessors greatly improved inspection techniques through the use of coordinate measurement machines. Because the equipment could now be programmed, and the programs easily changed and adapted to meet changing requirements, design changes and prototype inspections could be done with greater flexibil-

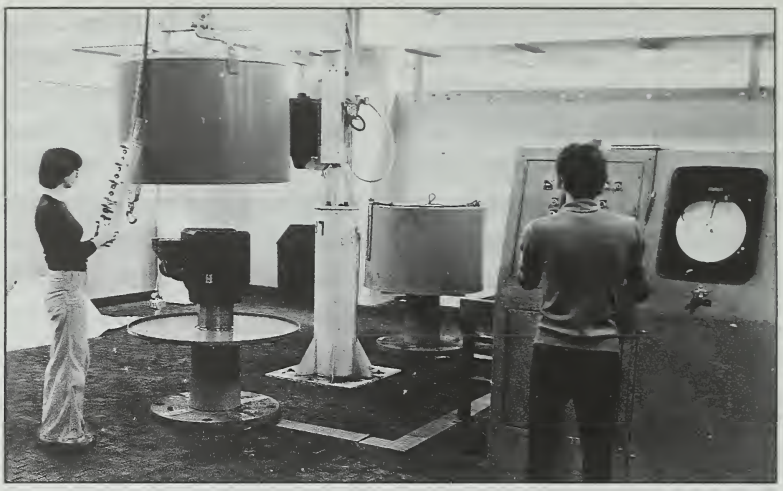
ity and efficiency. In addition, the ability of the computers to store information gave the Product Assurance Directorate the ability to detect and report trends in manufacturing errors — something they had been unable to do before.

Yet the principal reason for adding the new wing to Building 44, the Product Assurance Directorate, was to house an acceptance test facility that would simulate the live firing of weapons by means of hydraulic pressurization and gymnastication, thus providing safe and powerful weapons to troops in the field at a greatly reduced cost to the government.

Traditionally, all artillery pieces manufactured at the Arsenal had been live proof tested at proving grounds in order to "prove" their safety for use by field units. Proof testing consists of firing a gun at a pressure about 13 percent above the maximum normal firing pressure and then inspecting the breech mechanism for damage. If no damage had occurred, the gun would be accepted for use by the soldier in the field. By the late 1960's and early 1970's, the cost of live firing the high number of proof rounds required for a small sample quantity of guns was becoming very costly. As a result, the Product Assurance Directorate developed simulation testing equipment and techniques.

Simulation testing consisted of cycling a breech mechanism five times on a testing device known as a gymnasticator. A cartridge case would be loaded into the breech, the block closed, the cannon hydraulically recoiled, and the cartridge ejected. Next, the breech is transferred to a test stand where hydraulic fluids pressurize it to the appropriate level — 72,000 pounds per square inch in the case of the 105mm M68 tank gun. The breech is then disassembled and inspected. Both the breech block and breech ring are cleaned and examined, using magnetic particle inspection. Finally, the breech is reassembled and manually checked.

By substituting simula-



SIMULATION TESTING — Simulating actually firing pressures makes for more cost-effective testing.

tion testing for proof testing, the Arsenal would save the Army the cost of ammunition needed for live firing — between $300 to $500 per round — as well as the costs involved in transporting guns to the proving ground. The Department of the Army's decision to invest $2.1 million in construction and equipment for the new simulated test facility began to payoff very soon — after a year and a half operation, actual cost savings of more than $800,000 had been realized.

By 1975, the Arsenal had achieved another step forward in laboratory testing — this time in the area of fatigue testing. A team of scientists in the Benet Weapons Laboratory, led by Dr. Thomas E. Davidson, had developed a simulation test for determining the fatigue life of gun barrels that Army authorities calculated would save more than $90 million within the first three years of use.

Fatigue life refers to the number of times a gun can be fired before it cracks and fails as a result of the stress experienced by the gun barrel during firing. Before a weapons system is released to the field, the safe fatigue life of

that weapon must be established. Historically, this was done by live firing — an expensive proposition, considering that fatigue life assessment for a single weapons system may required as many as a 100,000 rounds of ammunition, at a cost of $300 to $500 each.

In lieu of live firing, the Benet group developed a simulated test firing technique that could not only determine the safe firing life of gun barrels, but also do so much faster and much more cheaply. The new technique, known as hydraulic cycling, could be done in a laboratory for about $2 a cycle — one cycle being equivalent to one round. And it could be done 10 times faster. This development, which the Benet group culminated in 1974, resulted in a laboratory simulation test for assessing the fatigue life of cannon that carried with it a cost reduction of 90 to 95 percent.

In 1975, Dr. Davidson and 11 other scientists, engineers and technicians from the Benet Weapons Laboratory who had been responsible for developing the new laboratory test procedures were presented with a $5,000 award. The citation accompanying the award credited the group with achieving first-year savings of more than $20 million for studying and establishing the correlation between hydraulic laboratory cycling and live firing. At the time the award was presented, it was the largest in the history of the Arsenal's Incentive Awards Program.

A few years later, in 1978, the same Benet team received an additional $20,000 award for their successful project. This time the award was presented to them at the Pentagon by Secretary of Defense Harold Brown and Civil Service Commission Chairman Alan Campbell. Added to the earlier award, this brought the total award value to $25,000 — the largest sum that could then be presented for a single project under the rules of the Civil Service Incentive Awards Program.

By the time the second award was presented, the laboratory simulation technique had been adopted not

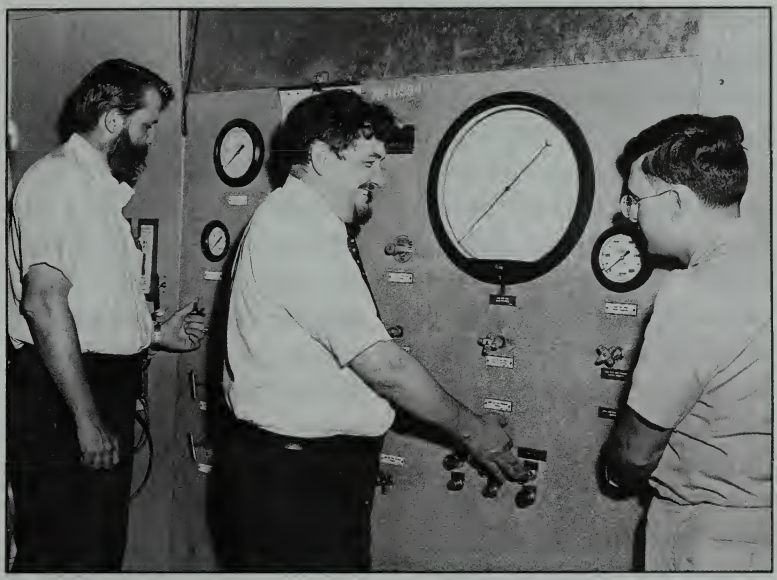
only by the U.S. Army, Navy and Air Forcce, but also by the Federal Republic of Germany. Accrued savings at that time were placed at more than $99 million.

Yet another Benet project received high attention in the 1970's — this one in the area of high pressure research and also under the leadership of Dr. Davidson, chief of the Research Branch.

While the practical application of high pressure knowledge in simulated testing had been saving the government millions of dollars for about two years, the purely research aspect of this Arsenal scientific program received Army-wide recognition in late 1977 when Dr. Davison and several of his assistants were granted the Army Research and Development Achievement Award for their work. It was the eighth time Benet Laboratory scientists and engineers were so recognized with this honor.

The Arsenal's research into ultra high pressure had begun in 1973 at a time when the highest static pressure that could be achieved in the laboratory was found to be 200 kilobars (2000,000 times normal atmospheric pressure), but theoretical projections pointed to the possibility that new materials needed, but not yet in existence, could be formed by raising pressures to levels between 500 and 1,000 kilobars. This was the goal the Arsenal researchers pursued in the next few years.

First they had to invent the equipment and develop the measurement techniques necessary to carry out their program. By 1978, the scientists had achieved pressures of 600 kilobars (600,000 times normal atmospheric pressure) and a new principle of pressure generation had been employed. These high pressure (90 million pounds per square inch), as expected, effected remarkable changes in the materials to which they were applied. Six new phases of materials were discovered, including two phases of bismuth which showed high electrical conductivity, and metallic states of sodium chloride, gallium phosphide



HIGH PRESSURE — Research into the uses of high pressure characteristics refined quality testing techniques.

and boron. sodium chloride is ordinary table salt. But one problem which the researchers foresaw could rob them of some of the usefulness of their work was whether or not the interesting and valuable properties shown by test materials under tremendous pressures would be metastable, that is, whether they would continue to exist at normal atmospheric pressures. In one case the answer was yes: cadmium sulfide, which had been rendered into a metal under tremendous pressure, retained some of the characteristics of a metal at atmospheric pressure and exhibited very unique magnetic properties.

Other goals of the high pressure researchers were more elusive. One of these projects, which came to national attention, was the search for metallic hydrogen, normally a lighter than air gas. Researchers hoped to achieve this by chilling the hydrogen gas through a liquid state to ice at 24 degrees centigrade above absolute zero (-217.16C) and applying great pressure to it. By

1978 they had invented new equipment to carry this out and had tested the hydrogen ice under 100,000 atmospheres of pressure, five times greater pressure than had ever been applied to this material before. The knowledge thus gained formed the basis for reaching even higher pressures in the pursuit of achieving the metallic form of hydrogen. Although the properties of such a substance were unknown, the potential existed for creating a superconductor, enabling electrical power to be transmitted with almost no resistance or loss, or a concentrated energy source that could have a variety of military applications.

In these years, Arsenal researchers also solved a riddle that gunmakers had been trying to unravel for more than 40 years. This solution gave promise of leading to a better understanding of a central problem of artillery manufacture and use. That was the erosion or wearing of the bore of a gun which begins with the first round fired, when the heat and gas effects of firing begin the formation of a microscopic "white layer" on the metal surface of the bore. In 1976 Arsenal researchers succeeded in reproducing the white layer phenomenon under laboratory conditions and thus seemed to have found a major key to understanding and ameliorating wear in artillery weapons. It held the potential for being of great help to the user services and bringing savings to taxpayers by giving weapons a longer life.

Work on composite materials for weapons manufacture was active during this period and produced some exotic items such as prototype tank wheel made up of wound glass fiber (much lighter and cheaper) instead of steel and a successfully-tested 106mm recoilless rifle made of epoxy plastic and high-strength steel wire over a thin steel tube. It was 40 pounds lighter than the standard weapon. This latter project was particularly aided by computer-assisted design and, indeed, modern computer technology was brought

into full play in Benet Laboratory work in these years. A technique called interactive graphics technology, developed under the laboratories computer-assisted design and engineering program, made it possible to cut months from the usual time needed to analyze stresses in weapon components and was a valuable tool in helping to forestall design problems.

While these developments were in progress in the Benet research organization, the Arsenal had undergone two changes of command in a relatively short time. At the end of July 1975, Col. Malcolm V. Meekison succeeded Col. Sawyer as the forty-second commanding officer of Watervliet Arsenal. On leaving Watervliet, Col. Sawyer had first been scheduled to assume command of Harry Diamond Laboratories, Alexandria, VA, but he was quickly reas-

NASTRAN — NASTRAN, a computer-aided design system, was employed in gun design research.

signed as project manager for the speeded-up production of the M60 main battle tank. The assignment was a further note of the Army's continuing desire to build up strong armored forces and a recognition of Col. Sawyer's experience and expertise in his field. Speeding the Arsenal's production of 105mm M68 tank guns for the M60 tank had been one of the priorities during Col. Sawyer's tenure as commanding officer.

Colonel Meekison, a native of Florida, came to Watervliet from the Army War College where he graduated in 1973 and had since served as director of military planning and force development. A West Point graduate, he held a master's degree in engineering science from Purdue and also was a graduate of the Army Command and General Staff College. In addition to serving two tours at the U.S. Army Missile Command, Redstone Arsenal, Col. Meekison had been an Ordnance assignments officer at the Pentagon. His overseas assignments included Germany, Lebanon, Korea, and Vietnam, where he participated in four battle campaigns from 1969-1970 and served two years as chief of operations at the Kwajalein Missile Range. During his 20-year military career, Col. Meekison had earned the Legion of Merit, Bronze Star Medal, Meritorious Service Medal, and Army Commendation Medal, and decorations from his Vietnam service.

Soon after taking command, Col. Meekison recalled from his Vietnam service that he had often encountered teams of Watervliet Arsenal civilian experts checking on the weapons their colleagues had designed and manufactured and helping to keep the guns in service in the combat zones. "Watervliet was very quick to come in and take over if there were any problems with their products. They were very concerned," the new commanding officer explained. "Those artillery pieces really pumped out the ammunition—day and night — and those pieces were an important part of Watervliet's

contribution to the war.... The Arsenal is a unique source of the largest cannon. A lot of people would say the uniqueness is in the capital investment, but it's the people who work here. They are the key. The institutional memory is unrivalled anywhere in the free world."

During Col. Meekison's command he continued to direct the trends of research and engineering development and production which had been dominant at the Arsenal in recent years. When he was called to a staff position at the Arsenal's parent command at Rock Island Arsenal, Rock Island, Ill., he was followed in the installation's chief leadership position in September 1976 by Col. Church M. Matthews Jr.

Watervliet was a return to familiar surroundings for Col. Matthews, who had been chief of the Benet Weapons Laboratory 10 years before. Born to an Army family at Fort Bragg, North Carolina, and a 1957 graduate of West Point, he arrived at the Arsenal from a position as deputy coordinator for Army Security Assistance, Office of the Army Chief of Staff. Col. Matthews held a master's degree in engineering from New Mexico State University and was a graduate of the Army Command and General Staff College and the Industrial College of the Armed Forces.

His other military assignments included chief of the Pacific/Southeast Asia Division in the Army's international logistics directorate, commander of the 197th Support Battalion at Fort Benning, Georgia, and tours at the Military Personnel Center and with the Joint Logistics Review Board. Prior to his first assignment at Watervliet, he had been with the 11th Airborne Division in Germany, at White Sands Missile Range, New Mexico, and an ordnance supply officer for the Republic of Vietnam Army.

Not long after Col. Matthews took command in 1976, he presided at a small but significant traditional ceremony in the Arsenal's Big Gun Shop. This was to mark completion and ship-

ment to field forces of the first of a new weapon, the 8-inch M201 gun-howitzer to arm the M110A2 self-propelled artillery system, the most powerful of a series of weapons designed and produced at the Arsenal during the 1970's. All were designed with the modern goals of greater range, power, accuracy and mobility. The new 8-inch howitzer met all these criteria and became the Army's most powerful conventional weapon. Extremely accurate, and with a nuclear capability, the new weapon was designed to replace the 175mm M113 gun and the 8-inch M2A1E1 howitzer in the same self-propelled vehicle and combine the best features of both of these proven weapons. Now the Army's heaviest artillery piece, the new howitzer was able to fire at the high-angle and shorter ranges required for a howitzer and also at the shallower elevations and longer ranges of a gun. The new weapon would fire conventional ammunition about 22 miles and with rocket-assisted projectiles could shoot about 25 miles. And, with only one caliber of ammunition instead of two to deal with, field units could ask for a much greater variety of ammunition.

The big 8-inch weapon joined two other Arsenal weapons of increased power in the Army's inventory. The Arsenal had delivered the first few 155mm M185 howitzers in 1972 and they had been produced in numbers since. Replacing the earlier M126 in the M109 self-propelled artillery system, the new 155mm howitzer was eight feet longer and provided considerably greater range. With a nuclear capability, the big 155mm weapon was also provided with a new family of ammunition, including such an exotic round as the "Copperhead", a laser-guided antitank missile. The much more powerful self-propelled system mounting the Arsenal's new weapon was described by experts as a key item in the Army's effort to increase artillery power in armored and mechanized infantry divisions.

About two years after

NEW 8-INCH GUN — Latest version of the 8-inch self-propelled howitzer is shown after fielding.

Col. Matthews helped to celebrate the first shipment of 8-inch howitzers, he took part in a similar ceremony when the first 155mm M199 towed howitzers were shipped. A completely new design, this weapon strengthened the artillery power of airborne and airmobile units. Light enough to be carried by a helicopter, it provided a range of 11 miles with conventional ammunition and 18 miles with rocket-assisted rounds.

A new 105mm towed howitzer with a unique design feature called "soft-recoil" (which earned its Arsenal designers an Army Research and Development Achievement Award) was standardized and accepted for service by the Army. But no orders for the new 105mm howitzer were received from the user services, since planners estimated that future battlefield needs would require more powerful artillery weapons and that weapons of 105mm caliber would be too limited.

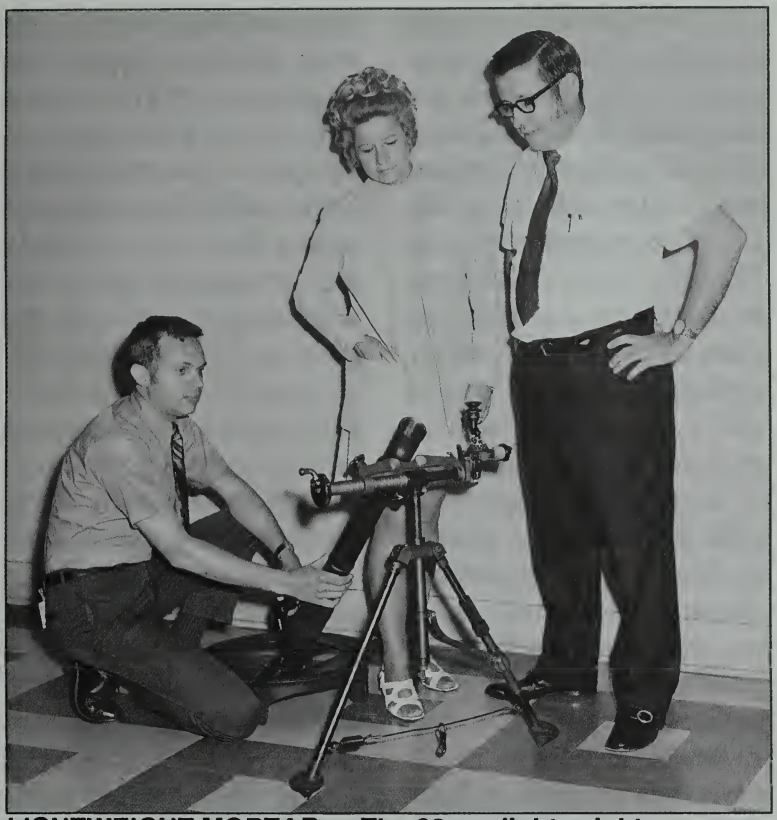
In May 1978 the Arsenal had received its first orders for production of the new lightweight mortar which had also earned its Benet Labora-

tory designers the Army Research and Development Achievement Award. This 60mm Lightweight Company Mortar System, the M224, for which Benet was the "project manager" with complete responsibility for the system life cycle, was a considerable advance over the 81mm mortar it would replace in non-mechanized infantry units. With about the same range as the older weapon, it weighed only 45 pounds complete with mounting systems and only 17.5 pounds in the hand-held direct-fire mode.

These powerful weapons were Watervliet Arsenal's contribution to the new generation of artillery weapons urgently needed to prepare the Army to play its role in world conditions of tension and difficulty. But while these difficulties required that new heavy and medium artillery weapons be provided to the field forces, as one military expert analyzed conditions, the Warsaw Pact's numerical superiority in tanks over NATO was estimated at four-to-one and growing. Thus the development and procurement of armored vehicles was the most critical of the Army's material programs and the subject of intensive, accelerated effort.

The Arsenal's production of the 105mm M68 tank gun had been continuing at very high levels in support of M60 tank production and M48 tank up-gunning (these tank programs were given the highest industrial priority rating of "DX"). But the question of whether there would be a new generation tank gun proved difficult. After two British-American-German tank gun competitions, some seemed to favor the German 120mm gun, but Arsenal authorities were assured by government officials that whether the German weapon was adopted or the U.S. 105mm gun retained, the tank weapons would continue to be made at Watervliet Arsenal.

Yet, as always, the higher standards demanded in the new weapons required more of an investment to meet those standards. For example, on the new combined artillery weapon, the 8-inch M201



LIGHTWEIGHT MORTAR — The 60mm lightweight company mortar moves into full production in May 1978.

howitzer, hydrostatic guided boring was used (the first time on so large a weapon), a nearly $2 million expansion of chrome plating facility was installed in Building 35, and a specially constructed 500-ton, 30-foot hydraulic swaging press (thought to be the only one of its size and type in the country) was installed in the Big Gun Shop. Production lines also required considerable rearrangement, as in the consolidation of all large caliber tube assembly functions in the Big Gun Shop. With practical foresight, each of the rearranged lines was set up to accept new advances in technology when they would become available.

The more sophisticated equipment that had been introduced and that which was anticipated would require a reliable source of trained people. One such source was a training program begun in 1974 for Vietnam veterans. It provided them with two years of training in a variety of shop jobs at the end of which they could hope for promotion within the shops or exercise their option to enter the apprentice school. In four years of operation, almost 400 Vietnam veterans were hired for the program and many became apprentices.

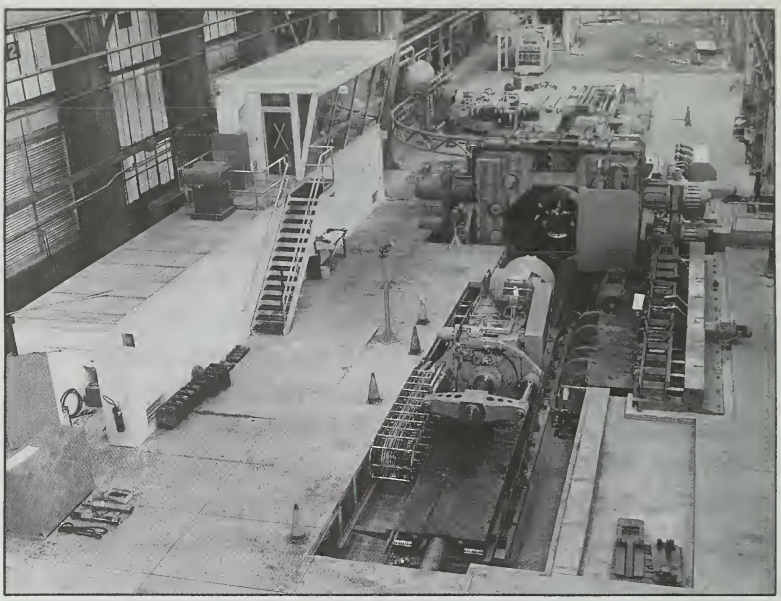
It was, of course, to the apprentice school that Arsenal Operations officials regularly looked to provide stable levels of needed skills in the work force. The need for skilled machinists was paramount and so in 1976 a third apprentice class was added to the normal two. Officials calculated that three classes a year for the next four years would be necessary to achieve the goal of keeping 300 machinists in the work force (no longer all men since Mrs. Yvonne Buck became the first woman apprentice graduate in 1978). The new and more sophisticated equipment also required new skills and so the apprentice school also added a journeyman program for electronics mechanics to service the growing number of numerically-controlled machines, and a heat treater course to provide the high level of skill needed in this field. The well-trained heat treaters would be especially needed to operate what was probably the most remarkable single piece of machinery ever to be installed at Watervliet Arsenal, the only such machine of its size in the United States and one of only a few of its kind in the world — this was the rotary forge for manufacturing gun tube forgings.

In 1977, the Operations Directorate manufactured four 105mm tank gun forgings on the rotary forge and reported that they proved acceptable in every way in their passage through machining to completion as finished tank cannon. Operations accepted the rotary

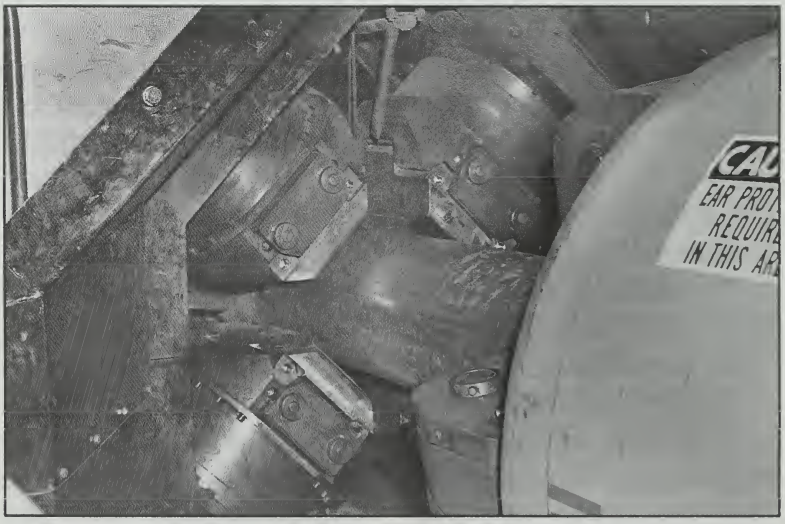
forge for regular production in December of that year, culminating a project begun in planning at the Arsenal 12 years before and which, just when it neared fruition, was almost captured by a private manufacturing concern.

The forge project came into being in 1965 when the Benet Weapons Laboratory Manufacturing Methods and Technology Group received funding through the Arsenal's Procurement Directorate for a study called "New Industrial Processes for Forming Cannon Components. "The series of studies which followed culminated in the award of a contract to GFM Company of Steyr, Austria, in March 1973, for manufacture of the giant machine for producing thick-walled gun tube forgings by hot forging, or thin-walled gun forgings by cold forging. By December of 1965 Arsenal officials were appearing at hearings of the House of Representatives Armed Services Research and Development Subcommittee to answer the demand of the Cabot Corporation, a steel forging producer, that the rotary forge should go to them. The corporation said its business would be hurt if the Arsenal operated the equipment, but Army officials replied that private corporations, including Cabot, had been asked to buy the forge but had refused on the grounds that it was too expensive and had no commercial application. The struggle for possession of the rotary forge had gone on for two years before the final decision was made in Watervliet Arsenal's favor. Through the cooperation of the Benet Laboratory and the Arsenal Procurement Directorate, the forge was delivered to the Arsenal in January 1975 and installed the following June in Building 135 where a 75,000 square foot site had been readied for it and the furnace system associated with it. Altogether it cost $14 million.

Dr. Robert E. Weigle, director of the Benet Weapons Laboratory, in writing for an industrial publication explained why the Army and the Arsenal had invested so much money and effort. He



ROTARY FORGE — The rotary forge, capable of producing gun tube forgings six times as fast as conventional methods, is ready for use in 1976.



HAMMERS — The four massive forge hammers, pounding at 200 times per minute, exert 1,000 tons of force each.

pointed out that it was 195 feet long and weighed 935 tons, making it the largest of its kind. It was capable, he said, of forging hollow cylinders (the shape of an artillery gun tube) from 6 inches to 18 inches in diameter and up to 33 feet in length and it could do this so that the forging produced would be so close to the final shape of the gun that the savings in steel would be very great. The forge operated by beginning with raw material in the form of a short steel "preform". Gripped by chuck jaws mounted on a moving platform, the preform was fed through a central housing where, while being rotated by the gripping jaws, it was struck rapid blows (200 times a minute) by four opposing hammers with a force of 1,000 tons each. Shaped by the hammer blows, the red-hot steel preform rapidly began to assume the form of a gun tube, and, gripped by a second set of jaws on the other side of the hammer housing, the new tube forging would emerge. For a 105mm tank gun forging the whole forging process took only about 10 minutes. One man in a sophisticated glassed-in control station complete with television monitors and a multitude of other electronic devices, directed the giant equipment with the help of only one floor observer. The properties of the steel in the forgings produced in this way were found to be excellent. Dr. Weigle noted that the rotary forge promised many advantages in artillery manufacture. He thought it might be possible to reforge worn-out guns "as good as new". Indeed, he admitted that the potential of so sophisticated a technological system was unknown. When it was explored and harnessed for weapons production, however, the savings in time and money promised to be very large. Recalling that government arsenals had sometimes been accused of being too conservative, the Benet Laboratory director gave it as his opinion that the acquisition of the rotary system by Watervliet Arsenal was a clear indication of its open-minded philosophy in regard

to the means of fulfilling its mission to the Army and nation.

Nearly as remarkable as the forge itself was the associated continuous horizontal heat treating system which was 288 feet long and could move the largest guns — 30 feet long, weighing more than seven tons — through the cylindrical furnace by means of powered rollers. After forging, this process took only eight hours for the 105mm M68 tube, compared to the 30 hours needed for conventional heat treating.

The fact that the sophisticated and expensive rotary forge was installed at Watervliet Arsenal was seen by many to be a vote of confidence in the Arsenal's future. But whether that judgment was valid could only be ascertained by comparing this event to a series of happenings which had been in progress for some time before 1977 and would not seem to reach a relatively final resolution until a year later in 1978.

In 1973 began the series of events which was to involve Watervliet Arsenal in a struggle at the highest military and political levels of government, the outcome of which would determine the future form of the Arsenal, or possibly, even its future existence.

In November 1973 a rumor began to circulate within and around the Arsenal that the Benet Laboratory was to be transferred to another defense installation (an earlier fear that they would be sent to Rock Island, Ill., had failed to materialize). The concern was frequently expressed by Arsenal people and friends of the Arsenal that if the research and development functions should be divorced from their unique and intimate union with the specialized skills and specialized equipment of the manufacturing function, it would not be long before heavy weapons production would be turned over to private industry and the Arsenal's gates permanently closed.

Not long after, Arsenal union officials met with Congressman Samuel S. Stratton, representative of the 28th

Congressional District in which the Arsenal was situated, to ask that he speak for the Arsenal in the deliberations on its future then in progress. Representative Stratton, a ranking member of the House Armed Services Committee, assured the union representatives very firmly that he would do so and he became a leading promoter of the Arsenal's cause through the years that followed.

But other than rumors, Arsenal people had little real information about what actions were being taken at the highest Army levels. In September 1974, the then new Arsenal commanding officer, Colonel Sawyer, told area business leaders that he had received no word on the installation's future from the Army Materiel Acquisition Review Committee, the organization conducting the study of Army research and development activities with a view of gaining greater efficiency and saving money through consolidation of installations and functions. But he offered the assurance that "I cannot foresee anything in the future that would hinder the effectiveness of the Arsenal."

A few months later, in December 1974, Congressman Stratton stated what were to be the main arguments of those who wished to retain integrated manufacturing and research and development at Watervliet Arsenal, that is, that the current co-location would in fact best serve the interests of the Army and national defense with efficiency and economy greater than geographical separation of these interdependent activities.

The congressman noted: "The best interest of our national defense, as well as the interests of saving in the national defense budget, require that the Army make greater use of the facilities of the Watervliet Arsenal, not talk about reducing any of its functions.... The major production tasks of the Watervliet Arsenal today involve guns for the Army's standard main tank, the M60. This is the tank that the Israelis need to deter further aggression in

the Mid-East, and it is also the tank our forces in Europe need a lot more of to achieve greater parity with the Warsaw Pact forces in Eastern Europe."

After the long period of uneasiness without real information on the progress of consolidation studies, the Army Materiel Acquisition Review Committee released its proposals at the end of February 1975. Three alternatives for reorganization were proposed:

• Headquarters and all laboratories to be located at Aberdeen Proving Ground in Maryland, or

• Large caliber research functions to be located at Picatinny Arsenal, Dover, N.J., and all other research functions to be at Aberdeen Proving Ground, or

• Large caliber and small caliber laboratories to be located at Picatinny Arsenal and chemical and ballistic laboratories to be located at Aberdeen Proving Ground.

These alternatives for the establishment of an Army Development Center, would embrace the research development and engineering functions of ARMCOM, Rock Island Arsenal, Frankford Arsenal, Edgewood Arsenal and the Ballistics Research Laboratory as well as Watervliet Arsenal's Benet Weapons Laboratory. The projected savings from the consolidation was $80 million.

The day after these proposals were announced, Congressman Stratton made strong representations on Watervliet Arsenal's behalf to Secretary of the Army Howard H. ("Bo") Callaway. He said it seemed to be counterproductive to take the research and development functions away from Watervliet, and on the contrary, it would be a better plan to concentrate greater research strength at Watervliet where it would benefit from the proximity of specialized manufacturing abilities. He said that he had told the secretary in very strong terms that he was "emphatically opposed" to the transfer of about 600 Arsenal employees (Benet researchers and supporting staff) which he said would be car-

ried out "over my dead body."

Col. Sawyer explained that as yet there had been no decision, and that it was not likely there would be one until the end of the year. His forecast was correct, and it was not until early December 1975 that the further disposition of Benet was decided at the highest Army and Department of Defense levels.

Up until this time the activities and sometimes the language of all concerned were intense: Arsenal employees of all strata formed a committee to evaluate the consolidation plan and present an alternative of their own which would keep Benet at Watervliet Arsenal and still achieve the desired goals of economy through greater efficiency. Mr. Fred J. Clas, director of Operations, Mr. Michael Gilchrist, director of Procurement and Mr. Paul Hasselgren, Comptroller, with Congressman Stratton presented their plan to Secretary Callaway in Washington, D.C. The secretary was said to be "impressed." But on a visit to Watervliet Arsenal in mid-June 1975, the secretary was still unsure about Benet's future. In early October Congressman Stratton attempted to amend the defense appropriations bill to the effect that the Watervliet Arsenal could never be closed or any part of it transferred. The measure was defeated when his colleagues declined to intrude so specifically into military decisions. In mid-October Assistant Secretary of the Army Harold L. Brownman visited the Arsenal but declined to speculate on Benet's prospects. Rumors persisted that Benet would be moved, but in November Congressman Stratton reported yet another promise from then Secretary of the Army Martin R. Hoffmann that no decision had been taken. But the decision, long looked for, was not far away.

At the beginning of December 1976, the decision came: the Benet Weapons Laboratory would stay at Watervliet Arsenal physically but organizationally they would pass to the control of the newly-formed Army Armament Research and De-

velopment Command headquartered at Picatinny Arsenal in Dover, New Jersey. Further, there would be a cut of 53 Benet "spaces" and 53 "spaces" from the Arsenal's logistics-supply organization would be transferred to ARMCOM headquarters at Rock Island Arsenal. Due to attrition, few people were actually lost from Benet.

All the participants in the protracted struggle expressed their satisfaction at the outcome. Congressman Stratton said Army authorities "were favorably impressed" with the case made by Arsenal people for the retention of research and development functions at Watervliet. The then new commanding officer, Col. Meekison, noted that the Secretary of the Army had reached that decision because of the "unusually close tie" at Watervliet between research and production. On reconsideration, he said, Army authorities had found it was not cost-effective to move the Benet researchers, and their large and complicated testing equipment. In the following January, hundreds of Arsenal people honored Congressman Stratton, and the other federal, state and local officials who had aided him, for his work in support of Benet and the Arsenal as a whole.

A year later, in December 1977, when Army Secretary Hoffmann visited the installation, he remarked that the Army was in the final stages of a three-year program to establish a permanent system of Army bases following a period of employment cutbacks. The new arrangement, the secretary said, would result in a fixed number of permanent Army installations. Watervliet Arsenal, he indicated, would be one of them.

A few months later, in August 1978, came an event which seemed a sure ratification of all these expectations and a guarantee of Watervliet Arsenal's future — approval by the joint conferees of the House of Representatives and the Senate of $20.5 million for Project REARM (REnovation of ARmament Manufacturing) or, as it was usually called, simply "mod-

ernization." Modernization — a six year, $150 million project — was to be the most significant plan to strengthen and expand Watervliet Arsenal's weapons manufacturing base since the World War II expansion more than 35 years before.

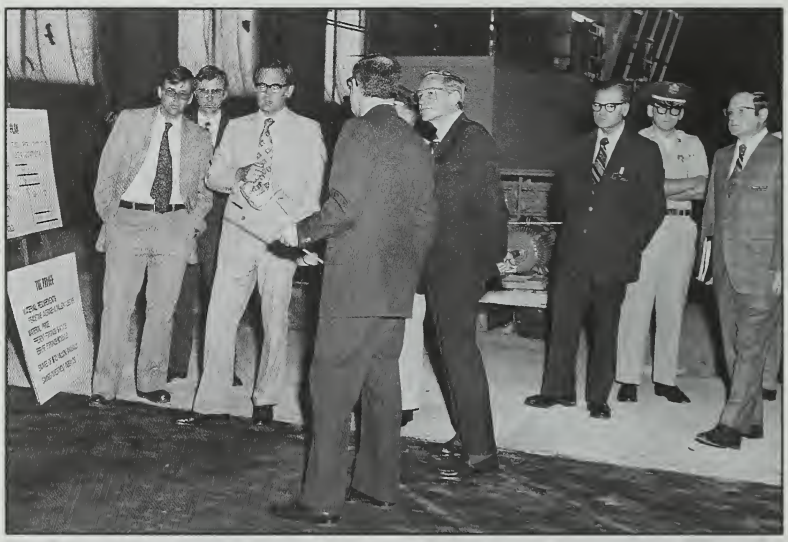
The project had begun four years earlier when Arsenal officials, well aware of the strain placed on manufacturing equipment and buildings by the demands of production for the Vietnam conflict — a problem made more serious by the fact that much of the manufacturing equipment dated back to the Korean War or even World War II — commissioned the Detroit, Michigan, engineering firm of Giffels Associates to conduct a thorough study of the cannon production base and the Arsenal's manufacturing functions and to make recommendations concerning the modernization of these facilities. This was to be done with a view to bringing all of these up to the state-of-the-art in order to increase production flexibility and provide an increased

"OLD" ARSENAL — Aerial view of the "old" arsenal before REARM demolition and construction began.

ability to respond to the demands of a national emergency.

The Giffels study presented in June 1975 concluded that considerable savings could be made by a realignment of plant equipment packages according to caliber rather than by individual weapons. Thus, plant equipment packages would be set up to deal with 155mm weapons within that category for which mobilization responsibility was assigned. Further, the studies indicated that lead times could be shortened and economies achieved by retaining the manufacture of all thick-walled cannon for peacetime, war reserve and mobilization at Watervliet Arsenal and procuring all thin-walled weapons — mortars and recoilless rifles — from other sources. Central to the savings possible through these recommendations would be the modernization of the buildings and equipment necessary to carry them out.

The first result of the Giffels study was an Arsenal military construction project



STRATTON VISIT — Rep. Sam Stratton, instrumental in securing funds for the project, is briefed on REARM benefits.

to build two new manufacturing buildings, a new oil storage facility and to renovate several other buildings. Included was the demolition of several older buildings necessary to make way for the new construction. Plans were submitted also for the rehabilitation or replacement of 680 pieces of manufacturing equipment. Officials hoped to acquire a large number of programmable numerical control machines. Arsenal engineers and technicians were busy for many months and Col. Matthews, then the commanding officer, several times led teams to make presentations at command headquarters, the Pentagon and before Congress.

The planning and preparation that went into modernization was a long and involved process that began in 1972, during the tenure of Colonel Christopher S. Maggio, and reached a peak during Col. Matthews' years as commander of the Arsenal. The original request to obtain project funding to begin the necessary studies and planing was submitted in 1972, with the independent engineering study contract awarded to Giffels Associates in 1974. The study ended and the results were presented to the Arsenal in 1976. From that point, modernization efforts were heavily concentrated on obtaining the necessary approvals, funding authorization and appropriations required from the Arsenal's subordinate command headquarters (the US Army Materiel Readiness Command in Rock Island, Ill.), from the major command headquarters (the US Army Materiel Development and Readiness Command in Alexandria, VA) and from the Departments of the Army and of Defense. The ultimate approval authority rested with the Congress and the President's Office of Management and Budget.

To assure central management over modernization — which in May 1978 officially became known as "Project REARM," for REnovation of ARmament Manufacturing — Col. Matthews established a new office at the Arsenal in April

1977 originally called, appropriately enough, the "Modernization Office." It was staffed full-time by Joseph Baran, who had been employed as a staff engineer on equipment and facilities projects at the Arsenal for the previous 10 years. As project officer for modernization, later REARM, Baran would exercise central management control over the planning, direction, control and execution of the project.

During his two years of command at the Arsenal (September 1976 to September 1978). Col. Matthews spent an increasing amount of his time on modernization. He made it a number one priority, while not neglecting the Arsenal's mission and other programs, and personally directed and promoted it through the various chain of command channels and justification and approval levels. The time and persistent efforts he and Baran devoted to the program assured that it received the high-level attention and acceptance warranted by a project so critical to upgrading the country's national cannon base.

The happy results of these efforts was an announcement in the summer of 1977 that the Department of the Army had taken the first steps toward approval of the six-year, $150 million program by awarding a $735,000 architectural-engineering contract for design of the project. The contract was awarded to Lev Zetlin Associates of New York, N.Y. In August, a production equipment condition assessment of all 1,733 pieces of active industrial production equipment was initiated to determine total equipment requirements under Project REARM. The study identified equipment to be replaced or rehabilitated and also developed priority listings of equipment to be purchased over the five-year period from fiscal year 1980 to fiscal year 1984.

The total Project REARM cost request of about $150 million included requirements for both buildings and equipment. Construction was programmed in the fiscal year 1979 Military Construction Army (MCA)

appropriation at a cost of $27 million, to be completed in three phases over a five-year period — fiscal year 1979 to fiscal year 1983. This would involve demolition of some 19 obsolete buildings — many of them temporary wooden buildings of World War II vintage — construction of two major new manufacturing buildings and an oil storage facility and renovations to six buildings.

For the Arsenal, fiscal year 1978 (1 October 1977 - 30 September 1978) was a pivotal year for Project REARM. While negotiations were going on during the first quarter between Lev Zetlin/Giffels, Inc., and the New York District, Corps of Engineers, to initiate design of the proposed buildings, the construction funds in the MCA budget began to flounder.

Although the project originally enjoyed a very high priority, an OMB-directed cutback in the Department of Defense budget resulted in the development of a new

REARM — Model shows many changes to the arsenal layout as a result of REARM demolition and construction projects.

priority listing of all Department of Army and Department of Defense project requests. The Arsenal's modernization program came up during these discussions because contract award for Phases I and II of construction were scheduled for late in the fiscal year. This led to the conclusion that the award could be delayed a few months to the FY80 program with little adverse impact.

The final resolution came in mid-December 1977 when Secretary of Defense Harold Brown briefed President Jimmy Carter and received guidance to prepare a $126 billion defense budget. This resulted in the budget approval line being drawn just above the Watervliet Arsenal project. Deferring the funding to FY80 could have resulted in a delay of up to one year in occupancy of the first new building, as well as inflated project costs and deferred accrual of projected savings. Leading the fight to save the Arsenal project in the fiscal year 1979 budget were the New York State Congressional leaders, especially Congressman Samuel S. Stratton (28th Congressional District), in whose district the Arsenal was located.

In late January 1978, Secretary of the Army Clifford L. Alexander, Jr., requested that DoD approve a budget adjustment restoring the Arsenal project, justified on the grounds that it would be beneficial to the early strengthening of the country's national defense posture. Congressional reviews conducted in April included Col. Matthews, the Arsenal commander, who testified before the Subcommittee on Military Construction of the House Appropriations Committee.

Although the Senate was originally reluctant to approve more than the $2 million needed for demolition in the fiscal year 1979 budget, a joint authorization conference between the House and Senate Armed Services Committees finally authorized the full project in that year's budget for a total of $27.021 million. Subsequently, the joint appropriations conference between the House and

Senate Appropriations Committees approved the fiscal year 1979 appropriation of $20.5 million for the first two phases of construction. Final appropriation for Phase III construction would be requested for fiscal year 1982. This appropriation came only after the entire New York State delegation — including Cong. Stratton and Senators Jacob K. Javits and Daniel Patrick Moynihan — had written a letter to President Carter stating that the administration held a bias against the Northeast, especially New York, in allotting military construction funds and assigning defense facilities and forces to that region.

The $20.5 million for demolition and new construction was for the first year of a five-year building plan. The major demolitions would be made to Buildings 105 and 14. 19th century structures housing offices and small shop facilities; Building 30, the carpenter shop; the heat treat wing of Building 110; and a portion of Building 108 containing offices. Also scheduled for demolition were several small utility buildings.

The two major new manufacturing buildings would be added to existing Building 35. The west addition would be 110,000 square feet in size and would house facilities for medium caliber gun tube manufacturing. On the east side, 67,000 square feet would be added for heat treating, plating and supply operations. Construction would also include a new building for storage of petroleum, oil and lubricants, as well as renovations to six existing buildings.

Because the Arsenal had been a Registered National Historic Landmark since 1966, the REARM demolition and construction plan required the concurrence of both the New York State Historic Preservation Officer and the President's Advisory Council on Historic Preservation. To obtain these concurrences, the Arsenal prepared and submitted extensive documents detailing the impact, alternatives and mitigative measures that would be taken to preserve the his-

toric nature of the Arsenal. These documents were fully coordinated with the New York State Historic Preservation Officer and the President's Council. Negotiations with both organizations resulted in a Memorandum of Agreement, following the procedures outlined in the Nation Historic Preservation Act of 1966 and other federal and state laws. This action was pioneer for the Department of the Army. The Arsenal's agreement represented the first ever concluded between a military installation and federal and state preservation officials. As such, it was touted as a model and precedent that would be followed and consulted by other military installations in the future.

Also approved in the fiscal year 1979 defense budget was $13.5 million for new and rehabilitated machines. This marked the first installment of some $130 million for equipment that would be requested over a six-year period. REARM included plans for buying and rehabilitating several hundred machines. These included lathes, milling machines, grinders, threaders, broaches, presses and boring machines.

In May 1978, a master plan for Project REARM was published and distributed throughout the Department of the Army. The plan was based on 1982 mobilization requirements that related cannon and spare tube production to planned force structure and ammunition consumption rates. This plan established courses of actions needed to meet requirements based on economics, responsiveness, and the capabilities of both commercial and government facilities. In developing the plan, priority was directed toward those modernization efforts required to support planned peacetime procurement of tank guns and artillery.

One of the most important components of the master plan was the equipment upgrading requirements. The results of the equipment condition assessment completed earlier were reviewed by Booz-Allen Applied Research, Bethesda, Md. In

their final report, furnished in February 1978, Booz-Allen found that the criteria used by the Arsenal in determining equipment conditions were comprehensive and that the data supporting the priorities and budget estimates was accurate. Booz-Allen concluded that "there is substantial evidence for a large program to restore lost capability and to compensate for continuing wear and tear on at least 420 machines." To meet future peacetime production requirements and to provide a responsive and reliable emergency production capability at Watervliet Arsenal, the assessment showed the need for investments of more than $130 million for the purchase of 492 pieces of equipment and rehabilitation of 188 machines. The project requests for this effort were submitted in the Department of the Army's Production Base Support Program in January 1978, along with a strong Manufacturing Methods and Technology (MMT) program needed to insure that goals for improved productivity and return-on-investment for the six-year upgrading plan would be met.

The first definite steps toward carrying out the massive modernization program were taken in March 1978 when design work was started for Phases I and II of construction. The joint venture was done by Lev Zetlin/Giffels Associates, Inc. with the New York District, Corps of Engineers, overseeing the work and administering the necessary contracts. Demolition and the beginning of construction were scheduled for early the following year.

Before this long-awaited work could begin, however, the Arsenal would have another change of command, Col. Matthews, who had made modernization the prime concern of his command and had seen the program successfully through its first critical tests, announced in September 1978 his reassignment to the U.S. Army Missile Research and Development Command, Huntsville, Ala. His new assignment would be project manager for the VIPER antitank missile system.

The new and now 44th commanding officer of Watervliet Arsenal was Colonel Robert W. Pointer, Jr. A native of Portland, Oregon, Col. Pointer was a 1958 graduate of West Point. He also held a master's degree in mechanical engineering from New Mexico State University and had completed the Command and General Staff School and the National War College. During his Army career, Col. Pointer had served in assignments at White Sands Missile Range, N.M.; Fort Riley, Kan.; Fort Carson, Colo; Germany and the Republic of Vietnam. His field service included battalion command and command of a General Support Group. During four years at the Pentagon, he was a weapons analyst in the Office of the Deputy Chief of Logistics and later worked on the reorganization of the Army in the Office of the Army Chief of Staff. Col. Pointer came to the Arsenal from Warren, Mich., where he had been product manager for heavy equipment transporter systems. He assumed command of the Arsenal on September 8, 1978.

Within only a matter of weeks after assuming command, the new commander was host to a distinguished delegation of officials headed by Secretary of the Army Clifford L. Alexander, Jr. Secretary Alexander, who inspected plant facilities and was shown the rather impressive operation of the rotary forge, when he was interviewed by local reporters at a brief press conference said that he had no alarming news for the Arsenal workers, but rather wished to tell them and the community that Watervliet Arsenal's work was needed for the defense of the nation and that the future of the Arsenal was stable.

With a program of about $117 million, a full two-year workload forecasted, employment stabilized at about 2,500 and Project REARM getting underway, the Arsenal's prospects did indeed look healthy as Col. Pointer took command. It would be his task to lead the installation through the important first years of mod-

ernization, to direct the continuing emphasis on the production of modern weapons for armored and mechanized warfare, and to maintain Watervliet Arsenal as the vital and reliable national defense resource it has always been through its 165 years of service to the country.

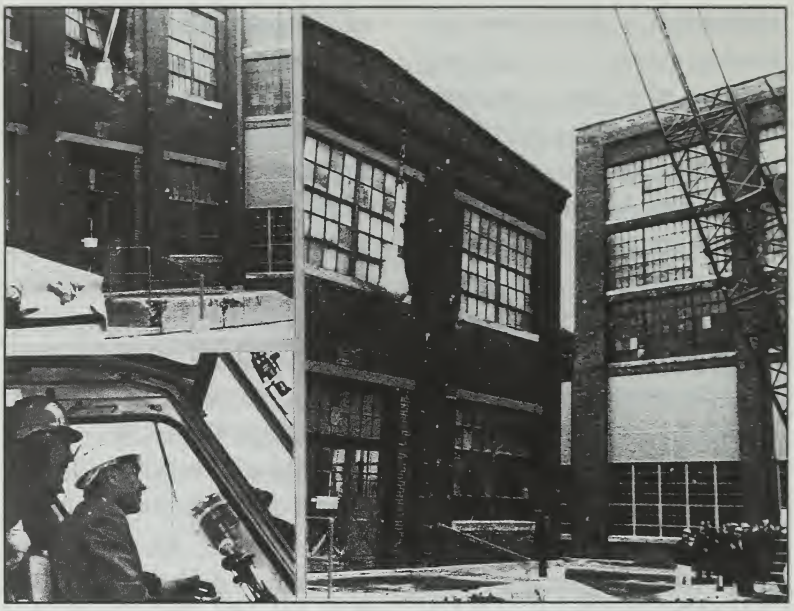
Six months into Col. Pointer's command, hundreds of Arsenal employees were witness to an impressive and certainly historic event when Project REARM was officially christened in a formal ceremony held on the Arsenal grounds.

In a fanfare marked by ruffle and flourishes, speeches by Army and Congressional dignitaries, and the climatic crash of a wrecking ball into Building 105, Project REARM got underway with a highly successful ground breaking ceremony on Friday, March 30, 1979.

An estimated crowd of some 1,200 Arsenal employees and invited guests gathered in early spring dampness under overcast skies to witness the event, which marked the official beginning of Project REARM at the Arsenal. In his opening remarks, Col. Pointer set the tone for the ceremony, saying that it "followed many hard years and months of work in preparing for Project REARM. We have been planning REARM, hearing REARM, and talking REARM. Today, for the first time, we start to see REARM."

And see it employees and guests did, despite the threat of downpour, as a two-ton wrecking ball, suspended from a massive crane, was set into motion by Congressman Samuel S. Stratton to make the first hit on Building 105. Vacated the previous October by Facilities Engineering, 105 was the first of 19 obsolete buildings to be demolished under Project REARM in order to make way for construction of the two major manufacturing buildings and a new oil storage facility.

Rep. Stratton, of the 28th Congressional District and a member of the House Armed Services Committee, gave the keynote address just prior to entering the crane cab to op-



WRECKING BALL — Rep. Sam Stratton operates crane to swing wrecking ball to demolish Bldg. 105 for REARM.

erate the levers that delivered the first blow to Bldg 105. Recalling the Arsenal's long history and record of service to our Armed Forces, "Sam" called the day an historic date in history of Watervliet Arsenal.

"I was a little surprised when I took a look at the program and saw what we are doing here today ... referred to as Project REARM," he said. "In the wake of the Vietnam experience, the federal government hasn't always used words that were quite as blunt as the word 'rearm'...but...in a sense this is exactly what we are doing today...We are beginning to rearm our facilities to meet the responsibilities that our country is facing around the world."

Referring to the "Iranian experience," Stratton said that "if we want to continue to protect our own way of life back here at home...we are going to have to assert ourselves...When it comes to asserting the strength and determination of this coun-

try, Watervliet is going to be in the lead not only in the Middle East, but also in NATO."

He concluded by saying "the one lesson that we can learn in our community and in our country—is to borrow a phrase that the National Guard has been using for some time—that, as we look at this project getting underway. 'You can sleep soundly tonight, because Watervliet Arsenal is awake!' "

Also speaking at the ceremony was Dr. Walter B. LaBerge, Under Secretary of the Army, who recognized "the heritage" that the Arsenal had "given to us in the United States and in the Army." He praised Arsenal employees for their "honesty, ingenuity and industry" and exhorted them to "continue that heritage."

General John R. Guthrie, commanding general of the US Army Development and Readiness Command (DARCOM), said that is "difficult to overemphasize the importance of REARM to the Army. It marks, if not a new beginning, a much delayed and long overdue renovation of one of our nation's most important military facilities." He also said that through REARM "we are signaling both to our friends and to our potential adversaries our commitment to the continued readiness and ability of this weapons production base to support our Army's needs."

"I would not presume to tell you...that Watervliet Arsenal has established a reputation for excellence in supporting our Army's and our Navy's and our nation's defense needs that is unsurpassed. You are proud of that reputation, and I and all of us in DARCOM are not only proud of it, but we profit from it," he continued.

Following his keynote address, Cong. Stratton was escorted by Col. Pointer to the cab of the crane owned by Bloomfield Building Wreckers, Inc., Troy. Climbing behind the controls, the congressman received last-minute instruction, then — to the accompaniment of a drum roll—pulled the levers that sent the wrecking ball through the south wall of

Bldg. 105. The perfect hit sent bricks, window frame and glass crashing into the second floor and to the pavement below, leaving behind a gaping hole. For his actions as a "doer," Cong. Stratton was made an honorary employee of Watervliet Arsenal.

Following the wrecking ball ceremony, a model of the Arsenal after REARM was unveiled by Congressman Gerald B. Soloman, 29th Congressional District, Colonel Christopher S. Maggio, retired, Colonel Church M. Matthews, Jr., and John Stiffen, president of NAGE Local R2-98. Col. Maggio, commander from 1971-73, and Col. Matthews, 1976-78, were instrumental in launching Project REARM and in obtaining Department of Army and Congressional approval.

A REARM commemorative certificate was presented to the Arsenal employee with the longest continuous service, Dan Tierney. Tierney, employed in the Force Development Office, retired April 6 after 44 years of service. Earlier in the day, every Arsenal employee had received a similar certificate, each personally signed by Col. Pointer.

In a surprise addition to the ceremony, Joe Baran, REARM project officer and master of ceremonies, called Civilian Welfare Council members Jan Spairana and Craig Baker to the podium to make a special presentation to Col. Pointer. On behalf of all employees, Spairana and Baker presented "past, present and future Arsenal commanders" with an oil painting of Bldg 105, done by retiree Lillian Hynes, long a mainstay of the Arsenal Art Guild. The painting was later hung in the reception area outside the Commander's Office.

Immediately following the hour-long ceremony, all employees received free box lunches in their work areas, courtesy of the Restaurant and Civilian Welfare Councils. The lunches were packed the afternoon and evening before by dozens of volunteers from throughout the Arsenal, including members

of the two councils and of NAGE.

Adding color to the ceremony was the 199th Army Band (Governor's Own) New York Army National Guard, led by Bandmaster W01 Michael Mosher. The 30-member band played a rousing half hour of pre-ceremony music while employees and guests gathered at the outdoor site. The 199th opened the ceremony with the National Anthem and concluded it with the stirring strains of the Army Song.

Delivering the invocation and benediction was the Reverend (Major) John F. Connolly of the National Guard 205th Support Group, Troy.

The ceremony was the end result of months of advance planning by an Executive Committee whose members included: Chairman, Lincoln Dietz, Chief of Transportation; John Germain, Director of Product Assurance; Mike Minahan, Production Control Chief; Maureen Gour, Public Affairs Officer; Lieutenant Colonel Ken McCollister and John Kacharian, Director and Deputy Director of Facilities Engineering; Joe Baran, REARM Project Officer; and Doris Hoffay of the EEO Office.

Employees and organizations from throughout the Arsenal contributed ideas, labor and long hours to make ground breaking an overwhelming success. The event was, in every sense of the word, a team effort of which all the employees of Watervliet Arsenal could later be justly proud.

Even before the day was over, handwritten letters of thanks and praise from employees, as well as congratulatory phone calls and personal comments, were received in the Commander's Office and by many others involved in the planning and execution of the ceremony. In the days and weeks following ground breaking, letters of thanks arrived from many guests and participants, including several local government leaders who attended. All were generous in complimenting the Arsenal on the fine performance.

With the ground breaking ceremony a part of Arsenal history, the real work and challenge of REARM began as the program got underway. In the words of Gen. Guthrie, "although modern buildings and machines may be the keys, the power to turn those keys rests with the men and women who operate them."

So, with the ceremony now history, the real work of Project REARM lay ahead. The crash of the wrecking ball through the south wall of Building 105 was the symbolic beginning. Planning had actually begun year's before and the real nuts and bolts work was just starting. Demolition, utility work and construction of a replacement Petroleum, Oil and Lubricant Storage Facility paved the way for construction of the major new production facilities. Final designs for both new production buildings were readied by Giffels Associates, Detroit, Mich., and Lev Zetlin of New York City.

When on July 25, 1979, bids were solicited based on the completed design, Arsenal managers knew the dream was coming true. On September 27, 1979, a contract for $18,554,000 was awarded to Sweet Associates of Schenectady, N.Y.

Although demolition and major construction were highly visible evidence of REARM progress, the revamping of industrial equipment was equally — if not more — important if modernization was to be achieved. Fiscal Year 1979 brought the first significant procurement appropriation for equipment. More than 20 major items of plant equipment were to be modernized and rehabilitated at a cost of $13 million. In many cases, the types of machines required for the unique task of cannon manufacturing had not been built since the last time one was ordered by the Arsenal. It quickly became apparent that delays would be the rule and patience a virtue. Backlogs for machine tools for the massive retooling in the auto and aircraft industries meant that it would be difficult to attract qualified machine tool builders to supply the highly spe-

cialized machines for gun tube production. For example, an attempt to find a supplier for horizontal turret broaches resulted in no acceptable proposals. When Arsenal managers tried to purchase hydraulic straightening presses and power chamber grinders, only a single acceptable proposal was received for each item. Solicitations for large 40-foot computer numerically controlled lathes attracted a number of offers from English, French and German firms but not a single domestic supplier.

Needing to make the machine tool requirements more attractive to industry, the REARM staff went back to the drawing boards. Where feasible, orders for larger quantities of the same type of machine were established. Communications with machine tool builders was improved through pre-solicitation and pre-bid conferences and even visits by Arsenal staff to their plants. Even so, by the end of Fiscal Year 79, no major contracts were awarded for new equipment.

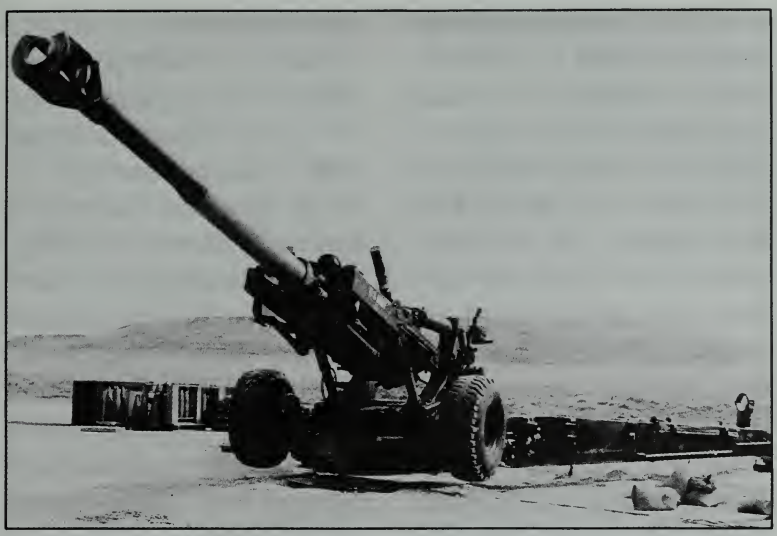
The Arsenal workforce continued to display their professionalism and determination. The production continued on schedule. And, even with all of the uprooting and shifting of shops, Arsenal workers showed their usual resourcefulness. Two Maintenance workers, John Aini and Philip Rosney, for example, worked on the own time to rebuild an 80-year old scale that would have cost $100,000 to replace. Because weapons couldn't be weighed for rail shipment, they had to be shipped by truck. Rebuilding the scale would mean the cheaper and easier railway shipping could be used.

Even the company that had build the scale, Fairbanks Scale Co., had long ago scrapped plans and blueprints. So the duo decided on the "seat of the pants" method. Some parts were fabricated in Arsenal shops. When the scale was finally assembled, the Delaware and Hudson Railroad sent an agent to calibrate the scale. No adjustments were needed. The scale was in perfect balance.

Knowing that inconveniences would be necessary to build for the future, the Arsenal workforce kept up with production schedules. In April 1979, the Army awarded a $212.9 million contract to Chrysler Corp. for second year production of 353 XM-1 main battle tanks. The first year plan was for 110 to be delivered in early 1980 with this second order due in 1981. With Watervliet Arsenal providing the guns, a steady production capacity was insured. The tank, however, was causing problems. The turbine engines were not functioning properly and there were suspension problems. Army Secretary Clifford Alexander Jr. quickly pointed out that "none of these problems are program stoppers." Good news for the Arsenal. There were reports that the tank's engines failed once every 338 miles but these problems were eventually worked out. The Arsenal continued to produce 120mm guns for these main battle tanks.

Also in 1979, the first of the Army's new M-198 towed howitzers arrived at Ft. Bragg. Sixteen were in the first shipment, all carrying 155mm guns produced at Watervliet. Orders for 600 were on file through 1984. This was indeed good news at a time when there was talk in Washington of closing several military installations. The Arsenal's future remained sound. New York State as a whole faired well. An Army engineering unit went to Ft. Drum and an Air Force radar unit was stationed at Griffis Air Base near Rome, NY.

Public fascination with the Arsenal was evident early in 1979 as more than 600 local residents toured the facilities during an open house day. It was the first such open house held on a regular working day in many years and the operation of the rotary forge was the star attraction. The Arsenal drew media attention in April 1979 when contractors, working on the modernization project, unearthed human bones. The skeletal remains were dug up along the south boundary as construction crews were pre-



NEW WEAPON — A new arsenal product, a 155mm gun for the new towed howitzer M198, is fielded in 1980.

paring utility lines. It was determined that this site was originally Gibbonsville Cemetery in the early 1800s. The May Memorial Day ceremony was yet another event which was well covered by local newspapers. More than 500 Arsenal employees who served in the Vietnam conflict were given green pins.

"Soldiers who served in Vietnam," said Col. Pointer, "were not asked if they wanted to go...though as citizens they might have questioned whether this is where we want to expend our young men and the strength of our nation ... they still served. There is no question in my mind that the future of the Arsenal depends upon the Vietnam Era veteran." In a candid interview with a local newsperson, Col. Pointer expressed his feelings about the Arsenal. He stated unabashedly that the Arsenal was his favorite assignment in a long and varied career. "It's the job. It's the responsibility. It's the mission of Watervliet and the people here are the most capable and dedicated force I've ever seen."

Another former com-

mander of the Arsenal, the late Col. Keith T. O'Keefe, was the subject of a special ceremony held Aug. 15, 1979. The Arsenal cafeteria was renamed O'Keefe Hall in his honor. His wife Marguerite said: "He courted me in London, where he was stationed. One day he said to me, "Maggie, I've invested so much money in food in you that I'm going to marry you." She praised the Arsenal family saying that Col. O'Keefe had held a special place in his heart for the Arsenal.

Still another former commander was in the news, Col. M. Matthews Jr., commanding officer from 1976 to 1978, was promoted to brigadier general. Matthews was instrumental in getting the original funding for Project REARM. After leaving the Arsenal, he was assigned as project manager for the Viper missile system at Redstone Arsenal in Alabama.

The rumblings of conflict were heard on the horizon once again in 1979. Students in Tehran, Iran, stormed the U.S. Embassy and held 62 Americans hostage. An Air Force general, in Albany, NY, for a Veteran's Day parade, would not comment directly but said the armed forces were ready. Rep. Gerald Soloman said, if necessary, the U.S. should use military force to bring home the hostages. Such force would not be used and it would be more than a year before these Americans returned home.

The Arsenal entered the 1980s with building construction in high gear. Purchases of new machine tools, however, continued sluggish through no fault of Arsenal planners. Only 85 percent of the first year appropriation of $13 million had been awarded. A Fiscal Year 1980 appropriation of $30 million was approved. Most of the first year's funds were spent on materials handling equipment, a micro-processor positioning control system, cranes and hoists. Eighty percent of these machines contracted for in 1979 were to be numerically controlled, a computer-like system,

which would make them more versatile and decrease manufacturing errors while increasing productivity.

Contracting out. This term would be part of the Arsenal vocabulary for years to come. A policy was established and put into practice in Washington that the government should not compete with private industry. The concept would allow private industry to bid on jobs they felt they could do more cheaply than government owned and operated plants. "Contracting out doesn't work," said an Arsenal union official. "We thought the program was in the formation stage. And we've been fighting it every step of the way. Before we knew it, it was upon us." The Army had directed its industrial installations to seek outside contracts for jobs that could be done more cheaply than by in-house employees. If the bidding firm could provide the service 10 percent cheaper, it had to be contracted out. Ten firms had bid on the Arsenal's custodial service. The bid by union employees was highest and bids from private firms were 10 percent below current costs so the Arsenal had to contract out his service. ARS Enterprises of Fayetteville, NC, got the job for $317,535 annually. The in-house bid was $787,143.

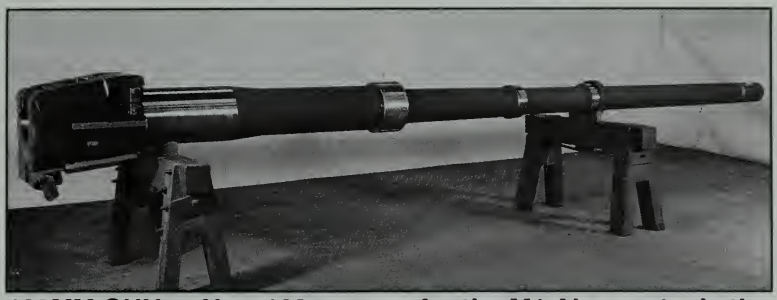
There were, however, many problems involved in implementing the contracting out philosophy. Some claimed contractors would not provide as comprehensive a service but would stick to the letter of a contract. Managers of Army installations realized they must be prepared to compile exacting bids so that in-house and outside bids would be based on the same services and not be an apples-and-oranges type of dilemma. Others felt that contracting could save taxpayers' dollars. Cong. Samuel S. Stratton, an ardent supporter of the Arsenal, filed a formal protest with the Department of Defense and Army Secretary Clifford Alexander. "It is my understanding," Stratton said, "that these positions were being reserved entirely for veterans as part of a federal pro-

gram to promote hiring of veterans...I feel we ought to be doing what we can in helping the veterans to find a productive reentry into civilian life, not be putting further obstacles and disappointments in their way." The contracted custodial service remained but it wasn't the last time the term contracting out would be heard at the Arsenal.

The in-house workforce nevertheless continued to meet all production schedules. And ingenuity and cost-consciousness were in force. A system for using scrap 8-inch M2A2 gun tubes to produce several usable components was developed. Using the rotary forge, one scrap 8-inch tube could produce two 105mm M68 forgings or two 155mm M185 forgings. The savings totaled millions. A new M68 forging, for example, cost $3,200. Using the scrap 8-inch tube, an M68 forging could be produced for $1,200, a savings of $2,000 on each forging! Even the old M2A2 breech rings were recycled. One scrap M2A2 breech ring could be made into a new 8-inch M201 howitzer breech mechanism and several smaller components as well. This, too, it was estimated saved $5,000 per breech and, with 400 ready for recycling, millions of dollars were saved. Still another inventive use of scrap involved the 12-inch piece of steel cut from the breech end of new M201 tubes. This piece, previously discarded, was made into a guide for the swage mandrel. Saved — $1,000 each.

After lengthy testing, the new 155mm self-propelled howitzer was fielded by the Army carrying the M185 cannon produced at Watervliet. Testing had also continued on the XM-1 main battle tank with the problems eventually being solved. The German-designed 120mm smoothbore gun was produced by the Arsenal. Watervliet also received in July 1980 a contract for in-house procurement and manufacture of 150 8-inch howitzers with the M209 tube assembly.

The workload appeared stable as the Arsenal welcomed a new commander on



120MM GUN — New 120mm gun for the M1 Abrams tank, the Army's main battle tank is displayed.

July 11, 1980. Col. Gerald R. Wetzel assumed command of Watervliet Arsenal from Col. Pointer in an outdoor ceremony. Col. Wetzel came to the Arsenal from Alexandria, Va., where he was executive officer to the commanding officer, Army Material Development and Readiness Command. A graduate of Notre Dame with a bachelor's degree in chemical engineering, Col. Wetzel had also completed the basic and advanced Ordnance Officers Courses, Armed Forces Staff College and Industrial College of the Armed Forces. He also earned a master's of business administration from George Washington University.

His first assignment was as Research and Development Staff Officer, Army Rocket and Guided Missile Agency, Huntsville, Ala. He then served as a battery officer in Okinawa and battery commander, Nike Hercules, 2nd Battalion, 61st Artillery. He was a staff officer at the Ordnance Guided Missile School. In 1966-67, Col. Wetzel was logistics advisor in Ahwaz, Iran, and the following year served as executive officer at Sierra Army Depot, Herlong, Calif. He then joined the staff of the Chief of Research and Development, Headquarters, Department of the Army. In 1971, he went to Vietnam to become executive officer and later commander, 8th Support Battalion, 196th Light Infantry Brigade and then Deputy Chief of Staff of the

1st Regional Assistance Command, Hue, Republic of Vietnam. He served in Germany and then returned to the Washington area as Chief of the Support Forces Group, Concepts Analysis Agency. From there he was assigned as executive officer Material Development and Readiness Command, his last assignment prior to Watervliet. Col. Wetzel, his wife, Mickey, and their seven children quickly settled into Arsenal life.

In his first newspaper interview, Col. Wetzel said, "From the family springs the strength of society. How can I tell a crane operator how to do his job when he's performed that job for 41 years? The operators and staff here have been doing their jobs well for years." The commander saw his job as "making sure the work is organized and stable so that workers can continue to approach their jobs efficiently." This accent on efficiency was echoed later in 1980 by Gen. John R. Guthrie, DARCOM. "To continue as a viable command," Gen. Guthrie said, "and to do our jobs in a professional and competent manner, we have only two alternatives — get more people or get more out of the people we have. The latter, from all signs I've seen, seems to be more likely." The new commander of Watervliet Arsenal had reason to feel confident in the productivity of his workforce. They had performed admirably throughout its history. And the installation of Computer Age machinery would also help with productivity. In September 1980, the Arsenal became the first buyer of Westinghouse's in-house computer tape operations center. Adding 40 numerically-controlled machines to the 60 on hand made the Arsenal the largest numerically-controlled machine tool operation in the Department of Defense.

The Arsenal Apprentice Program noted its 75th anniversary in June 1980. Hundreds of skilled craftsman had been produced by this model training program since it inception. Wages for the first graduating class had been eight cents per hour. In 1980,

this wage had risen to $5.43 and climbed even higher in the inflationary economy of the 1980's.

Entering 1981, the Arsenal was healthy and vibrant. Workload continued at healthy levels and construction and modernization kept a hectic pace. This healthy profile was significant in light of figures released by the State of New York showing that, at the end of 1980, the state had lost more than half of its defense workforce since 1950. It was estimated that closings of military facilities in the state alone had cost New York more than 44,270 jobs since 1965. In January 1981, DARCOM gave the word to Watervliet to raise the employee strength to 2,188. The Arsenal hired 137 machinists and machine operators and filled a variety of clerical posts in six days.

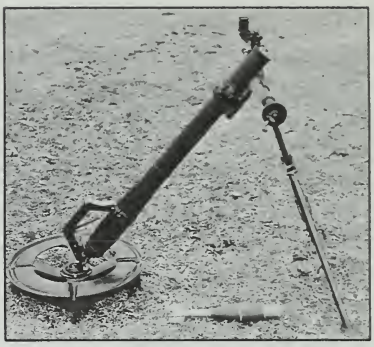
Arsenal managers and representatives of the union reached agreement on a new contract. A six-member employee safety committee made up of non-supervisory personnel was created. Upward Mobility, the program allowing people in dead ended jobs to work their way into new positions and learn new skills, was formalized in the contract.

On February 8, 1981, Cong. Stratton told a conference of his personal plan to see the XM-1 tank built in Watervliet. Stratton said land was available to the west of the Arsenal. "Why not build the tanks near the source of the cannon?" he asked, Plans were for 7,058 of the tanks to be build at $1.9 million each. Chrysler Corp. had received the contract to build the first models but the tanks were to be the Army's main battle tank to the year 2000. By the end of 1982, little more had been heard of this plan which would have dramatically increased the size of the Arsenal. Another proposal made by Cong. Stratton, however, was expected to meet with success. The Stratton Amendment as it was called was tacked on to the 1982 Defense Appropriations Bill. Its aim was to "prohibit the transfer of technical data packages from any government-owned and operated de-

fense plant — such as Watervliet — to any foreign government." Historically, there had been problems developing from providing cannon technology to foreign governments who later would end up in competition with Watervliet.

A new Army weapon, designed and produced at Watervliet, passed field testing with flying colors in April 1981. The 60mm Lightweight Company Mortar was the first new mortar produced by the U.S. in 25 years. Developed by Benet Weapons Laboratory and manufactured in Arsenal shops, the new mortar weighed only 47 pounds and had a range of 3,500 meters, nearly twice that of the 60mm M19 mortar it replaced. The new weapon also allowed for a high rate of fire due to improvements in the mortar tube and use of a cool-burning propellant in the high-explosive round.

While the Arsenal staff exhibited pride in the successful development of a new weapon, they also awaited the arrival of one of the classics in American weaponry — the 16-inch gun. Early in the year, rumors abounded that the Arsenal would be the site for the reconditioning of 16-inch guns for the Battleships New Jersey and Iowa. Plans were formulated to bring these World War II ships back into service. In September, Arsenal workers unloaded a 94-ton 16-inch battleship cannon. Made at Watervliet in 1942 but never mounted on a ship, the massive gun became a media event. Newspapers and television stations followed the gun as it was hoisted from a barge on the Troy side of the Hudson River and trucked through the streets of Troy, over Congress Street Bridge and into the Arsenal. The 16-



LWCM — Lightweight Company Mortar, a new product.

inch gun stretched 60 feet and was capable of firing a 2,000 pound shell 30 miles. This particular gun was only for display outside the Arsenal Museum but was a portent of what might be a new challenge for the Arsenal — dusting off the huge cranes and special equipment (as well as finding the skilled labor) to handle the 16-inchers.

Also adding to this juxtaposition of the new and the old was the creation of quality circles at Watervliet. Under the auspices of the newly-formed Organizational Effectiveness Office, quality circles made use of management techniques attempting to get the average worker more involved in the decision-making and problem-solving mechanism. Private corporations had become enamored with the success of Japanese firms and began to make use of Americanized versions of these Japanese tools, such as quality circles.

In mid-1981, the announcement was made that Col. Robert W. Pointer Jr., immediate past commander of the Arsenal, had been named brigadier general. That made it two in a row for former Arsenal commanders. A year later, Col. Pointer returned to the Arsenal for an informal, friendly get-together with the Arsenal staff and to tour the new REARM buildings he had helped launch.

A successful enjoyable year at Watervliet was marred by the first fatal accident at the Arsenal in 26 years. On Dec 4, 1981, Schuyler E. Yearsley Jr., 39, of nearby West Sand Lake, was testing a cannon barrel when an 80 pound mandrel shot out of the barrel and struck him in the head. A cold worker, Yearsley was testing an M201 cannon tube using the swage process. In swaging, a carbon-tungsten mandrel is rammed into the barrel to determine pressure tolerances. The cork-shaped mandrel is forced into the tube, the wide end of the mandrel being the exact size as the diameter of the barrel. Yearsley pulled the ramrod from the barrel but the mandrel did not follow. As he

looked into the barrel, the mandrel shot out striking him in the head. An Arsenal employee for 17 years, Yearsley was survived by his wife and two teenaged daughters. Industrial affairs experts for the Army conducted an investigation. "The investigation on board," a report stated, "concluded that the most probable cause of the accident was the failure of the swaging machine used to develop adequate force or pressure to successfully drive the cylinder through the gun barrel." As a result of this investigation, several changes in swaging were instituted. Employees were prohibited from looking into the gun barrel when a mandrel is struck. Tests and data were to be developed to safely seal off a barrel when a cylinder is lodged and a method would be developed to determine where in a barrel a cylinder is without looking into the barrel.

In February 1982, the Arsenal hired the first full-time curator for the Arsenal Museum, recognizing the need to catalog and display the Arsenal's priceless collection of weaponry, especially the historical development of cannon making. William H. Bradford was named curator. Bradford, a graduate of the University of Alaska and the State University of New York, brought extensive experience in museology to Watervliet. He had served as director of the King's Landing Historic Settlement at Fredericton, New Brunswick and was a site supervisor at Gen. George Washington's Headquarters site, Newburgh, N.Y.

Employment was averaging 2,560 including tenant commands and the operating program totaled $115.7 million in 1981 with $138.5 million expected in 1982.

A brief ceremony was held June 26, 1982, marking the start of Phase III of Project REARM, the final phase. Held in conjunction with the Arsenal's Family Day (an annual employee outing), the ceremony was brief and informal for there was no real dividing line among the three phases of the ambitious modernization. Rep. Samuel

FAMILY DAY — Rep. Stratton chats with arsenal managers during Family Day 1982 REARM ceremony.

Stratton swung a sledge hammer knocking a few bricks from the corner of Building 14, one of the few remaining buildings to be demolished. At this point, two of the new production buildings were in service. The first had been accepted for occupancy in February 1981 with new facilities for the manufacture, assembly and inspection of medium calibre gun tubes. The second new building was completed in September 1981 and was to be used for plating, heat treating, storage and a new shipping/receiving facility.

Phase III was to see the demolition of four buildings and the construction of a 35,000 square foot addition to the new building completed in February 1981. The project was designed so that this building could be built in two stages to allow for a more manageable operating system during construction. This addition was expected to be completed in 1984. Equipment purchases continued at a slow but steady pace with project managers confident all equipment would be in operation on schedule.

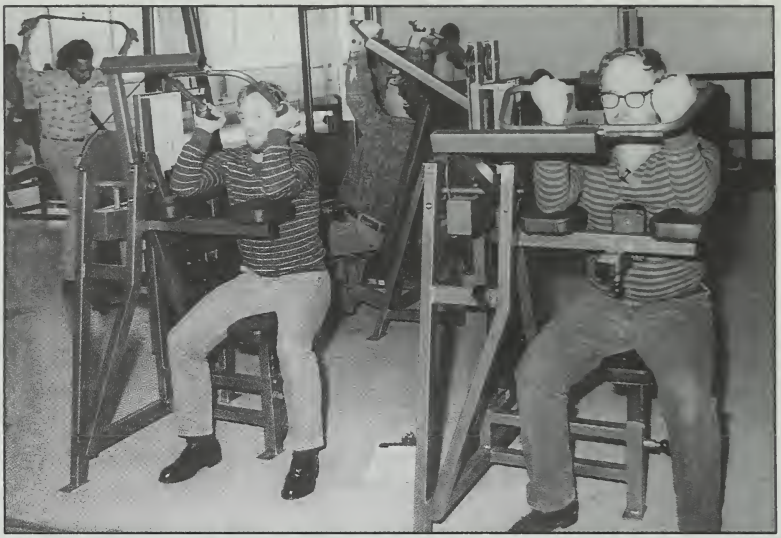
There would be a new

Watervliet Arsenal by 1985. This would be an Arsenal in tune with the times; an Arsenal of computerized and automated equipment housed in modern structures efficiently laid out. This new Watervliet Arsenal would approach the turn of the century as the most modern cannon facility in the world. And yet, as always, it would be the people of Watervliet, the Arsenal Family, as Col. Wetzel aptly put it, who would ensure that Watervliet Arsenal fulfilled its national mission. The people of Watervliet made the difference when making flannel cartridges in 1815 and the people of Watervliet — at the controls of automated machinery and trained in the latest manufacturing techniques — would make the difference into the new century.

Chapter 14
A New World, A New Arsenal

Vietnam was quickly becoming a painful memory and World War II's "Baby Boomers" began to move into management. They read the "secrets" of samurai management and took a flyer on Wall Street. The "Me Generation," would agonize through the changes of the 1980s as few generations had done before. The arsenal, too, faced a decade of challenges.

The physical changes of REARM were demanding but much easier to deal with than the philosophical shift needed to cope with a new world. The potential horror of nuclear war had, in effect, changed the game board. Since 1813, Watervliet Arsenal had faced ebbs and flows. Each time there would be a period of protracted peace, the critics would begin to suggest other uses for the arsenal. While no one was suggesting that the arsenal be closed in the midst of a $306 million modernization, it was clear that the days of relying solely on cannon purchases by American forces were receding into the sunset. Cannon remained the principle product but it was time to begin to think about new markets and, perhaps, new products.



BODY FORGE — A new physical fitness center, equipped with modern weight machines, opened in Building 40 in Nov. 1982.

In August 1982, Representative Samuel S. Stratton announced he was supporting legislation that would allow the arsenal to sell its guns to private U. S. firms under strict federal regulations and sanctions. Known as the Goodling Bill, the measure saved a great deal of red tape. In the past, if a U. S. firm wanted to sell a weapon system to India, for example, the firm would have to order a Watervliet Arsenal cannon from the Department of Defense. The federal government would give the order to the arsenal and the gun would be made. India would have to arrange for payment directly to the federal government before the guns were transferred. The private firm's weapon system, minus the gun, and the arsenal cannon, separately, would be shipped to India where they would be joined for the final product. Under the new bill, the private firm could order directly from the arsenal, attach the guns and ship the final product to India. All such dealings, of course, required the strictest of regulations and approvals by the State Department as well as

Department of Defense.

Later in the summer of 1982, the arsenal's Product Assurance Directorate pronounced its new M3 borescope a winner. One year after standardization, orders were pouring in — nearly 500. The borescope was an example of the innovative thinking that was necessary to carry the arsenal into the future. It was lighter and cheaper than its predecessor. And it was far superior.

Changes were occurring in the workplace environment, too. Managers all across the nation were being sensitized to the issues of sexism, racism, upward mobility, and equal opportunity.

A new health facility, named (by way of a contest) the Body Forge, was opened in Building 40 on Nov. 16, 1982, with a racquetball court, weight exercise machines, stationary bikes and the like. An outdoor physical fitness course was constructed with a number of stations at which the jogger would stop and perform the stated exercise. The Employee Assistance Office was helping employees cope with personal problems.

Concern for the environment placed added pressure on industrial firms to make certain the waste water they produced and the air they breathed from their stacks was harmless. The arsenal, with a reputation as a good neighbor, took the initiative.

Polychlorinated biphenyls (PCBs) were typical. Products using PCBs were invented for applications where it was necessary to dissipate heat. PCBs were used in brake linings, transformers, transmissions, etc. Then, years after first being put to use, researchers discovered that these chemicals were potentially hazardous to humans. PCBs, for example, were said to cause cancer. Long before the deadlines set by the army, the arsenal had gone clean through all shop areas, drained hydraulic machines, tested the fluids, removed all PCBs and labeled machines as "PCB Free." The arsenal was the first government agency to declare itself free of PCBs and the final report

on this project became a government standard.

The year closed on a low note. The arsenal had been facing the need for developing new products and cultivating new markets but the reality of this new financial environment set in with the announcement of something called Commercial Activity review.

Those words were to shape the thoughts and actions of many arsenalites for the next several years. The concept of CAR is that government should not be competing with private industry. If there are services being performed by government-owned, government-operated sites that could be performed by private industry, well, then, the private sector should have a chance to bid on these jobs.

Up until 1983, Watervliet Arsenal had been exempt from Commercial Activity Reviews. After all, this was the nation's sole facility for producing large caliber, thick-walled cannon. But, in the 1983 environment, all bets were off. It appeared likely that the arsenal would face CA review.

The process was time-consuming. The government would identify certain areas in which a CA review would be conducted. The arsenal would prepare detailed job descriptions and work requirements. From this material, the arsenal would prepare a bid to accomplish this work. And, private contractors would be invited to prepare bids on doing the same work. The arsenal would get a 10 percent leeway because of existing positions and practices. But, within that grace area, if the private contractor's bid was lower, they would get the job. As the employees of McAlester Army Ammunition Plant had learned, according to their base newspaper, "There was no getting away from the fact that in order to make the successful low bid, plant authorities had to promise to carry out the same work with 56 fewer employees."

That was it. CA review meant fewer employees. Even if the arsenal won the bids, it would mean doing

more with less. This phrase, as it turned out, would be repeated throughout the '80s and into the '90s. Like Reduction-in-Force in past years, no words caused more fretting in 1983 and 1984 than Commercial Activity Review.

Early on in the process, the Department of Army exempted 1,400 jobs at the arsenal from the CA process. These included all of Operations Directorate, all of Product Assurance Directorate and the Carpenter Shop of Facilities Engineering Directorate (which directly supported the cannon business with shipping crates.)

That still left 800 positions as potential CA targets. These positions were located in the Administrative Office, Motor Vehicle Operations and Maintenance, Rail Operations, and Facilities Engineering and Housing, to include Building Maintenance, Roads and Grounds, Boiler Plant, and Audio-Visual Services.

The review had actually begun in August 1983, but after more than a year of frustrating delays, changes and revisions, the examination of work requirements and the package of the scope of work were not completed until well into 1985.

Small business vendors were to have their proposals into the arsenal by July 31, 1985, with the anticipated bid opening and awarding of the contract in October 1986.

In the end, when the bids were opened, the arsenal's in-house bid was lowest. With the exception of janitorial service which had been contracted out earlier, all functions remained within the arsenal. However, the price for a winning bid was, as has been predicted, fewer people. Although these personnel reductions were accomplished principally through attrition, it was a sign that the arsenal would have to get lean and stay lean to compete in the new world marketplace.

Arsenal life went on during the CA review process. A new vertical, integrated storage and retrieval system was working just fine in

STACKER — A "vertical warehouse" is how the automated storage and retrieval system was described.

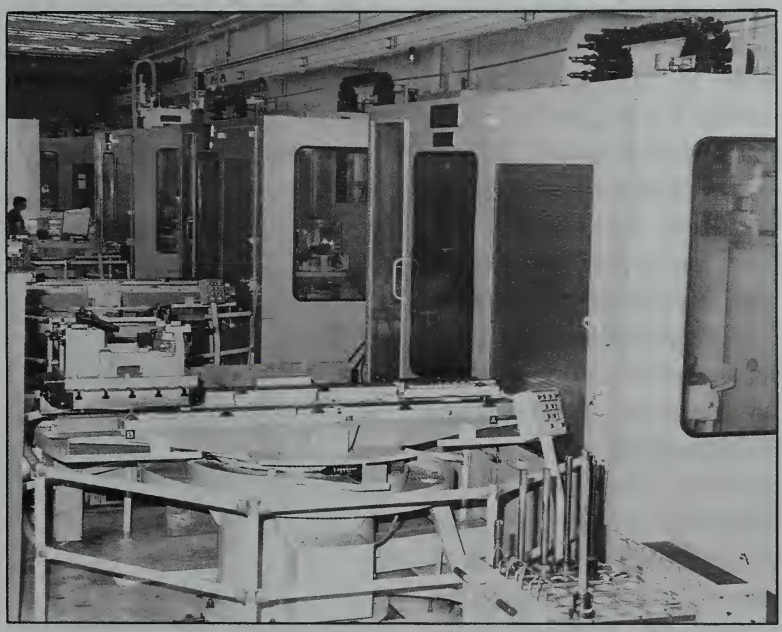
Building 35. Like a vertical warehouse, the "stacker" provided 1,600 pallet locations in a relatively small "footprint."

In a landmark procure-

ment, the largest single dollar-value purchase ever carried out by the arsenal, a contract was awarded to White Consolidated for a $15.3 million flexible manufacturing system. Designed to produce breech rings and breech blocks, the flexible manufacturing system would be a series of major machine tools linked by a central computer. In theory, a raw block of metal would go in one end and a nearly finished breech block or ring would come out the other.

The machining centers and vertical turret lathes would be joined by Automated Guided Vehicles (AGV) like robot forklifts, that moved along the ground on impulses from guide wires in the floor.

Several years later, the machining centers were in operation and the AGVs moving silently from station to station but, after changes



FLEXIBLE — The individual stations of the Flexible Manufacturing System are shown shortly after installation.

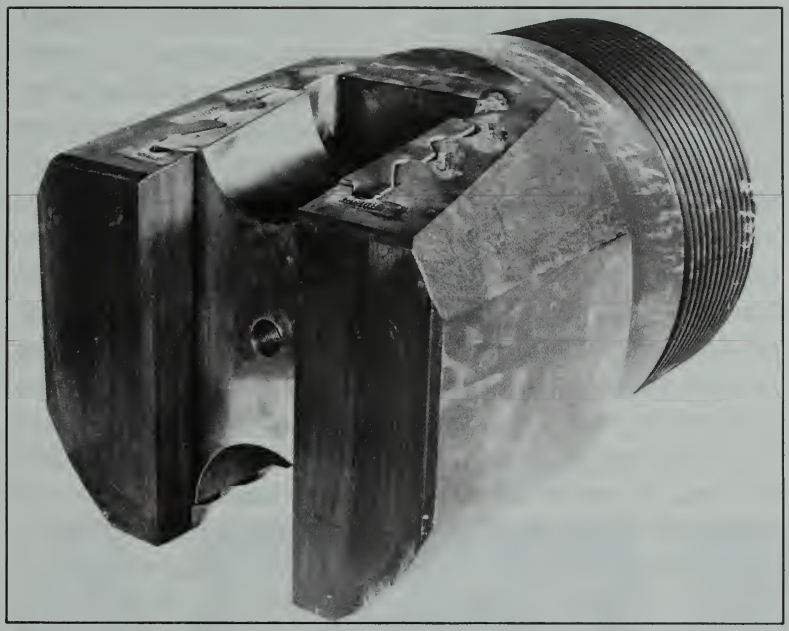
in the contract and the contractor, and sticky software problems, the system, as of 1993, had not reached the full integration once envisioned.

On July 19, 1983, Colonel Edward V. Karl became the 45th commanding officer of the Watervliet Arsenal. In an outdoor ceremony on a bright sunny day, Col. Karl received the flag of command from Col. Wetzel. Born in Yonkers, N.Y., Col. Karl graduated from St. Bonaventure University in 1959 with a bachelor's degree in mathematics and earned a master's degree in mathematics from University of Delaware. Not a newcomer to the arsenal, Col. Karl had served as research and development coordinator for Benet Weapons Laboratory in 1971 and then stayed on as executive officer from 1972 to 1974.

Col. Karl came to Watervliet from Washington where he served as staff director, Industrial Base Programming, Office of the Undersecretary of Defense (Research and Engineering.) Prior to that, he was commander of the Detroit Tank Plant. A tall, soft-spoken man with a quiet confidence, Col. Karl, by all accounts, was one of the most popular of commanding officers.

Along with a new commander, the arsenal got a new command. The U. S. Army Armament, Munitions and Chemical Command (headquartered at Rock Island, Ill.) replaced the former ARRCOM and ARRADCOM. The following year, the major command, the Materiel Development and Readiness Command (DARCOM) was out and the new name, Army Materiel

AMCCOM — The distinguished unit insignia for AMCCOM.



MULT-LUG — An improved multi-lug slide-block breech was developed by Benet in 1983.

Command (AMC) was in.

The new commander, well grounded in math and systems theory, quickly charged a study committee to develop a total automation plan for the arsenal. The arsenal had already seen the benefits in Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM.) REARM machine tools would be numerically-controlled. The FMS would be directed by a central computer.

Each new day brought smaller and still smaller personal computers with more and more power. Computer chips were turning up in every device in the home. Arsenal managers knew that they would have to embrace the latest in technology if the arsenal was to be ready for the 21st century. In December 1983, Col. Karl formed the Arsenal Automation Team. Headed by Joseph Baran, Chief, Production Planning and Con-

trol, the team was given six months to develop a plan to automate both the arsenal's business systems and its manufacturing systems and then to make certain that the systems could "talk" to each other. This would be an automation road map. The life of the committee stretched beyond six months. There was much more to this task than first thought. In fact, in the end, it would take the formation of an entire new directorate to guide the arsenal's exploration of advanced technology and systems.

On the hardware side of the house, 1983 saw the development by Benet Labs of a greatly improved multi-lug slide-block breech mechanism. This was a key element in Benet's contribution to ISAS — the Integrated Smart Artillery Synthesis. This was the Army's seedbed for artillery ideas and hardware for the future. Another Benet contribution was the concept of an autoloader for a self-propelled 155mm gun. Both ideas would prove valuable.

The massive REARM program reached a milestone in May 1984 with the dedication of the northern wing of Building 35, the end of REARM building construction. To mark the occasion, Col. Karl invited the 12 living past commanders to an arsenal reunion. Of the 12, six accepted. Five participated in a full weekend of festivities including a formal dedication, luncheon and past commanders dinner. It was truly an historic sight—six men who had led the arsenal seated at the same table! Col. (Ret.) Walter M. Tisdale, unable to make the ceremony, revisited on May 4-5. Hosted by Col. Karl, the festivities included: Lieutenant General (Ret.) Fred Kornet Jr. (who the year before had been installed into the Ordnance Hall of Fame at Aberdeen Proving Ground, Md.,) then-Col. (later Brigadier General) Robert W. Pointer Jr., Col. William Mulheron, Col. (Ret.) Christopher S. Maggio, and Col. (Ret.) Richard H. Sawyer.

Rep. Sam Stratton, guest

speaker for the dinner, said: "Being on the House Armed Services Committee, you have to have some kind of installation in your district to keep alive in order to remain on the committee. I found out that every once in awhile someone in the Pentagon will get an idea to do something with the arsenal. Then I found out that it really has nothing to do with the arsenal. They want something of their own passed for Texas or somewhere and know I won't let them do anything to the arsenal." It was an evening of comradeship; of relaxed humor.

In mid-1984, the tried and true team of Watervliet Arsenal and Benet Laboratories came through again. In 11 months from start of design to completion of the first pro-

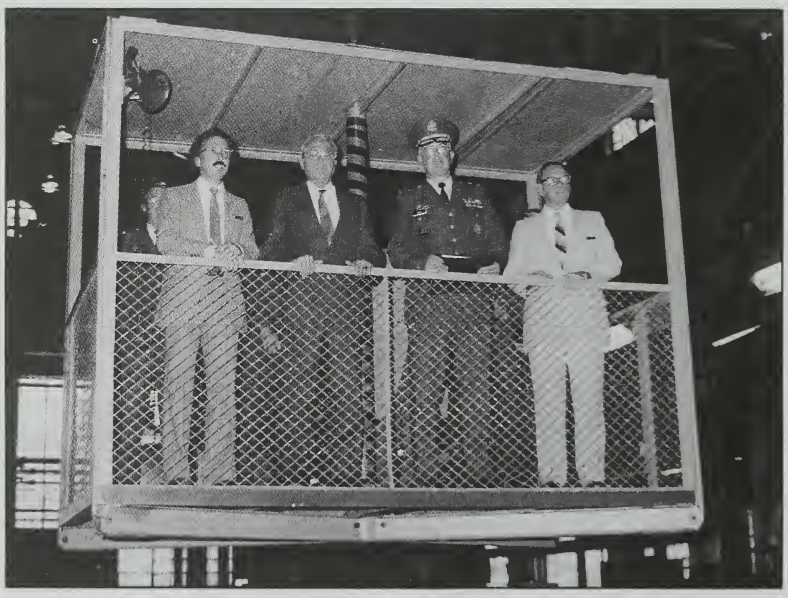
SIX COs — Six commanders of the arsenal (and four spouses!) gather on steps of Quarters One during reunion in 1984.

totype, the team produced a new lightweight 105mm gun capable of firing the full family of tank rounds. The technology developed would also be applied to lighter 120mm guns.

Secretary of the Army John O. Marsh Jr. visited the arsenal in October. An arsenal manager, Michael Minahan, was national president of the Federal Managers Association. He had invited Secretary Marsh to speak to the FMA's eastern regional conference. He accepted and included a tour of the arsenal in the visit.

"For much of the planet Earth," Secretary Marsh said, "it is a world of tears, turmoil and conflict. America, with its material and human resources, finds its leadership challenged, and its vital interests threatened."

On the tour of the arsenal, Secretary Marsh was given the eagle's eye view of the Big Gun Shop, riding the gondola down the center bay high above the machine tools. He was shown the new RE-



RIDING HIGH— Army Secretary John O. Marsh, Jr., rides the gondola high above center of Building 110 during tour.

ARM structures and the automated equipment. The secretary complimented Col. Karl and arsenal managers on a "national asset."

The year of remembrances and nostalgia ended with the dedication of the Big Gun Shop to Carl Alfred Christiansen, master gunmaker who established the original Seacoast Cannon Shop.

When Col. Karl had assumed command, he had announced his "I CARE" goals, each letter representing a goal (Installation master plan; Communications; Automation; REARM; and EEO and Energy Conservation.) As 1985 got under way, he took a giant step toward the "A" goal with the creation of the Advanced Technology and Systems Directorate, an outgrowth of the study committee.

REARM continued apace with the installation of dozens of new machine tools. The flexible manufacturing system neared completion and an installation master plan was taking shape.

FRED CLAS

Perhaps the most significant event of the year was the retirement of Fred Clas, director of Operations. To many people — perhaps, most — both within the arsenal walls and in the local community, Fred Clas *was* the arsenal. It could be said that no other individual since Carl Christiansen had such a lasting effect on Watervliet Arsenal. In a career that

HIP — The Howitzer Improvement Program proved to be a major hardware development of the year.

spanned 45 years, Fred Clas had risen from apprentice machinist to director of Operations, a position he held for 22 years.

Clas had been accepted for admission to Rensselaer Polytechnic Institute and was about to take up his studies when, on the suggestion of his father, he decided it would be a good idea to get "a year's working experience" first.

He never went to RPI.

Clas completed the four-year apprentice program in three years, working seven days a week.

Putting thoughts of college out of his mind due to the war, he decided to join the Navy and went to Sampson Naval Base, Sampson, N.Y. He was there just long enough to get his hair closely cropped — 19 days. An order arrived to discharge him from the Navy with instructions he immediately be enlisted in the Army.

"What the hell are you talking about? I'm in the Navy," he told officials, "I'm not going in the Army."

After basic training at Ft. Lee, Va., Clas got orders to none other than Watervliet

Arsenal. Now, instead of making $240 a month with all the overtime he wanted, he was getting $19 a month as a soldier doing the same job. A smart move by the government.

"As if that wasn't enough," he said in a retirement interview, "I came in at 7:30 a.m. and put in my eight hours. Then, after work, I reported to the drill field at the ballfield, and we had close order drill until dark and physical exercise. Then, after dark, they took us up into the second floor of the Broadway building and now we had military training in the classroom. At 11 o'clock they say 'OK. You're dismissed for the day. You can go home'. Seven days a week for 19 bucks."

It was shortly thereafter that Fred Clas hit on what he considers to be his most significant single contribution to the arsenal and his country. He developed a program for using carbide tools for milling. "I was the first one in the world to use carbide on milling." It was at a time when the country was in need of such technological breakthroughs. This increased the productivity of milling machines by a factor of 500 to 1,000 percent.

Following the war, Fred Clas experienced a meteoric rise. By 1955, at the age of 33, he was promoted to Deputy Director of Operations. He had gone from Methods Department to Chief of Planning and then Chief of Production Engineering. He was later named Assistant Chief of Manufacturing and then Deputy Chief of Operations.

In 1963, he was appointed Director, Operations.

Asked what advice he would give to someone just beginning their arsenal career, he said: "I guess what I'd say is never stop learning. Continue to develop regardless of age. And, associate with the leaders. Associate with the best talent you can find and get close to them. Learn from them. Listen. Be a good listener."

Fred Clas had been a tireless booster of the arsenal. A hard worker and, at times, a tough taskmaster but, as 1985

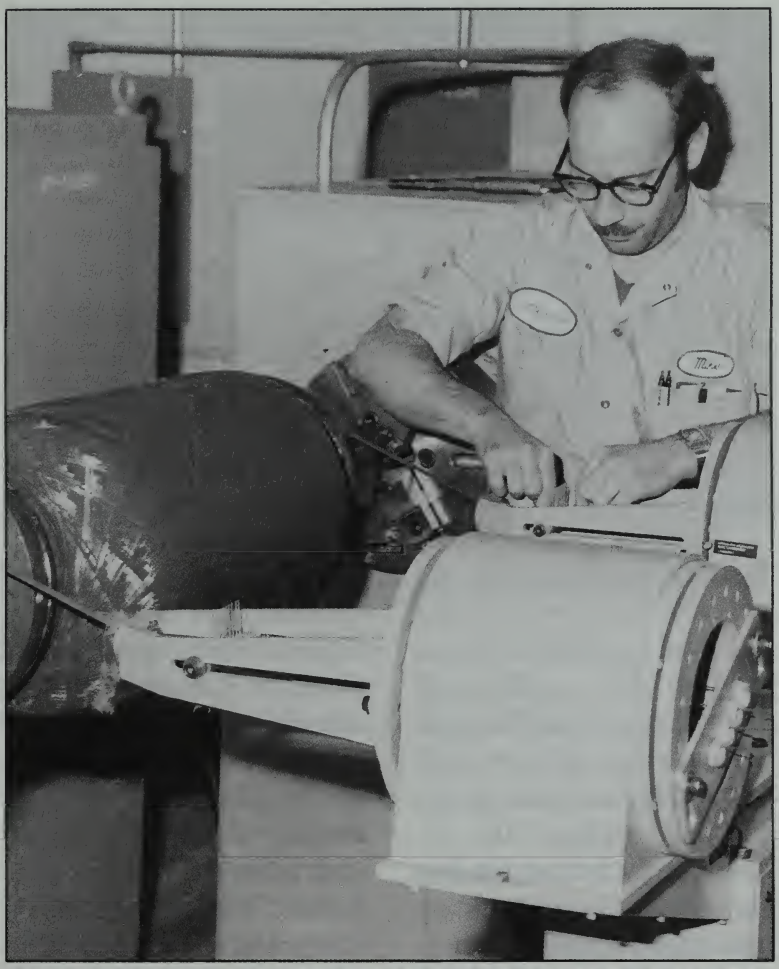
came to a close there was a sense of loss. And, although Clas continued to visit the arsenal and work in the armament field well into the 1990s, most around the arsenal in 1985 knew the place would never be quite the same. In 1988, he was inducted into the Ordnance Hall of Fame and in 1991 was awarded the prestigious Firepower Pioneer Award by the American Defense Preparedness Association.

The year ended in similar fashion to its predecessor: with the dedication of another arsenal building. Building 135 was dedicated to Frank A. Miller, arsenal superintendent of production during the difficult period of two wars and the most trying time of peace between them.

It was Miller who had conceived, supervised construction of and placed into service Building 135. He began his arsenal career in 1917 and in 1945 was awarded the Exceptional Civilian Service Award. He retired in 1953.

A major hardware development of the year was the Howitzer Improvement Program - the HIP. As 1986 dawned, Benet and Watervliet Arsenal worked closely on improvements to the self-propelled 155mm howitzer to make it a key player in the desperate drama that would ensue if the Warsaw Pact forces one day drove westward over the German border. Three cannon were being developed for the system to offer maximum battlefield flexibility.

On Jan. 22, Col. Karl passed command of Watervliet Arsenal to Col. Robert T. "Terry" Walker, the arsenal's 46th commander. A graduate of the University of Akron with a degree in mechanical engineering, Col. Walker earned a master's degree in industrial management from George Washington University. A native of Akron, Col. Walker served as the project manager, Advanced Manportable Weapon Systems at the U. S. Army Missile Command, Alabama. He and his wife, Irene, told the change-of-command audience that they felt like they



COMPOSITES — Filament winding of composite materials is used to produce new, lightweight bore evacuators.

were returning home in that the upstate New York area was much like their Ohio roots.

As Col. Walker arrived, another long-time arsenal fixture retired. Paul K. Rummel, director of Benet Weapons Laboratory, had begun his arsenal career in the summer of 1957 as a mechanical engineering consultant for the "Cold Work Group." He progressed steadily through the

research and development ranks, being named chief, Industrial Engineering Laboratory, Benet Laboratories in 1962 and associate director of Benet in 1977. He became director in 1981. Lawrence D. Johnson was named to succeed Rummel. Johnson had been serving as chief, Armored Weapons Systems Branch, Ballistic Research Laboratory, Aberdeen Proving Ground.

Rapid development was the accurate description for progress being made on the HIP. An important element fell into place in March of 1986 with the installation of a "pump through" low-contraction chrome plating facility in Building 110.

Directly behind the Big Gun Shop, another building was taking shape — Building 112. The new Gun Dynamics Laboratory, built on the site of the old proofhouse and keeping the same number, was in operation by late summer. The building consists of a high-bay east-west wing housing various test equipment and a deep pit for high-pressure static hydraulic test gear. The north-south wing contains two firing sites where weapons can be set up and fired into sand traps with an adjacent instrumentation room to measure results.

The structure added greatly to Benet's basic and applied research capabilities. Simulation is the key to the facility which allows for the testing and firing of smaller weapons, the results of which can be accurately applied to larger weapons.

A harbinger of the future was also to be found in a new filament winding production facility in Building 130. The age old quest of the cannon maker has been to make a gun as light as possible which can fire a projectile farther and more accurately than before. Through the use of composite materials, such as filament winding for bore evacuators, the weight of modern guns can be reduced significantly.

Less technical but certainly as warmly welcomed an addition to the arsenal was the opening of the new Watervliet Arsenal Federal Credit Union facility in Janu-

ROTTERDAM — Rep. Stratton, center, joins Col. Walker, left, and other VIPs at Rotterdam Housing groundbreaking.

ary. For the first time, the credit union had room for attractive offices and roomy customer service areas.

The summer of 1985 saw another arsenal milestone, the first woman first-line supervisor. Lynn McClellan, a graduate of the local General Electric machinist apprentice program, had joined the arsenal team three years earlier. It was the luck of the Irish as on St. Patrick's Day, Lynn was confirmed as Operations first ever first-line supervisor, in charge of 12 employees in Building 20.

For years, the arsenal had reluctantly been in the housing business. After the closing of the Schenectady Army Depot in the '60s, the housing units in Rotterdam, a town on the outskirts of Schenectady some 20 miles from the arsenal, were transferred to the jurisdiction of the arsenal commander. It was an added responsibility which, quite frankly at times, seemed to just be in the way of the manufacturing business. There was never enough money to do the job properly.

But, as 1986 came to a close, a ceremony was held at the Rotterdam site. Rep.

Stratton was instrumental in securing $1.5 million for the complete renovation of the site with upgraded electrical and heating systems, new bathrooms and kitchens and energy-saving improvements. The congressman took great pride in unveiling a plaque which stated that these very apartments had once been the home of former President Jimmy Carter. Carter had lived here for a year, from October 1952 to October 1953, while he attended nearby Union College as a Navy lieutenant commander.

If years had labels, 1987 at Watervliet Arsenal could aptly be titled The Year of Statistical Process Control. Col. Walker, a student of industrial management, was certain that the application of statistical methods would bring increased quality and reduced cost to arsenal manufacturing. The Office of Statistical Process Control was created (later to be called Statistical Methods) with the goal of applying statistical methods to traditional arsenal problem areas.

Based on the teachings of Dr. W. Edward Demming, the guru of Japanese quality, the arsenal began to apply two simple concepts to manufacturing processes: one — workers do not want to create defective work; and two — tracking the actual output of an operation or process, and applying statistical analysis, will lead to control of the operation or process well within desired limits.

Quality circles had come and gone but the verifiable results of statistical methods were here to stay. In the next decade, the program would grow to encompass a Total Quality Management program, to institutionalize the search for quality and customer service.

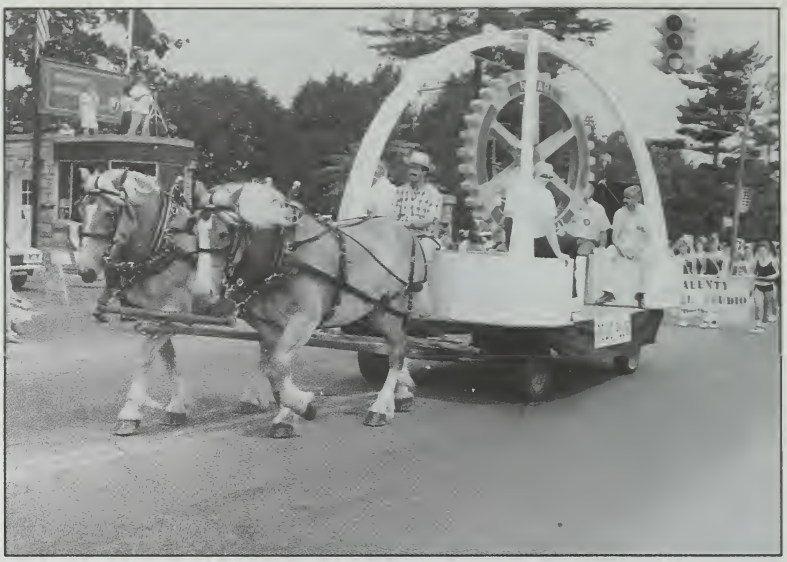
In January of 1987, six arsenalites were awarded the Department of Defense Productivity Excellence Award, one of the highest awards ever received by arsenal employees. The group had developed a way to manufacture the new 120mm tank guns that resulted in an estimated first year savings of

MUSEUM OPENS — The Arsenal Museum opens in the Iron Building after years of struggling for a permanent home.

nearly $3 million. And the savings were expected to continue for years to come. The original forging configuration required 32 hours of rough turning due to the large amount of stock which had to be removed. The new forging configuration was 600 pounds lighter, making machining much more economical; a nine-hour job.

Advancements were not limited to the shop floor in 1987. After more than 20 years of volunteer committees, dedicated amateur collectors and constant battling for dollars and recognition, the Watervliet Arsenal Museum opened its doors on May 22. In a gala grand opening celebration, Col. Walker and Rep. Gerald Solomon cut the ribbon opening the museum in the northernmost third of the historic Iron Building, Building 38.

Four years later, the museum would earn the ultimate in respect and recognition from its peers, Certification as an Army Museum, a standard more difficult to achieve than that set by the American Museums Associa-



GALA PARADE — The Rotary proudly display one of many floats in the 175th anniversary parade.

ARSENAL FLOAT — The 175th logo bedecks the back of the arsenal's float.

tion.

The arrival of 1988 was greatly anticipated. After nearly three years of planning, the arsenal would mark its 175th birthday with an ambitious week-long series of celebrations. To make the event even grander, the City of Watervliet joined in the planning and sponsorship making the celebration a community-wide extravaganza.

Church bells rang out, helicopters thumped overhead and the largest parade in Watervliet's history stepped out lively in bright sunshine

to kick off the festivities on Saturday morning, July 9. It was a grand affair. Red, white and blue ribbons were everywhere, seemingly wrapping the arsenal in one big birthday present. Attractive banners carrying both the City of Watervliet symbol and the arsenal's crossed cannons emblem were hung from streetlamps throughout the city.

The two-hour, six-division parade featured more than 5,000 marchers. An estimated 30,000 cheered along the parade route — nearly three times the population of Watervliet. The cheering seemed to crank up a decibel or two whenever an army vehicle or unit passed by.

The parade was followed by a now rare open house. The need to protect arsenal technology as well as the worldwide threat of terror-

MARCHERS — The arsenal contingent struts down Broadway during anniversary parade.

BIG SOUNDS — The First Army Band performs during the gala week-long 175th anniversary celebration.

ism had long ago ended the annual Armed Forces Day open houses. But, on this day, the arsenal's doors were flung wide open and thousands filed through the production areas getting a first hand look at the rotary forge in action or a large tank gun turning in a lathe.

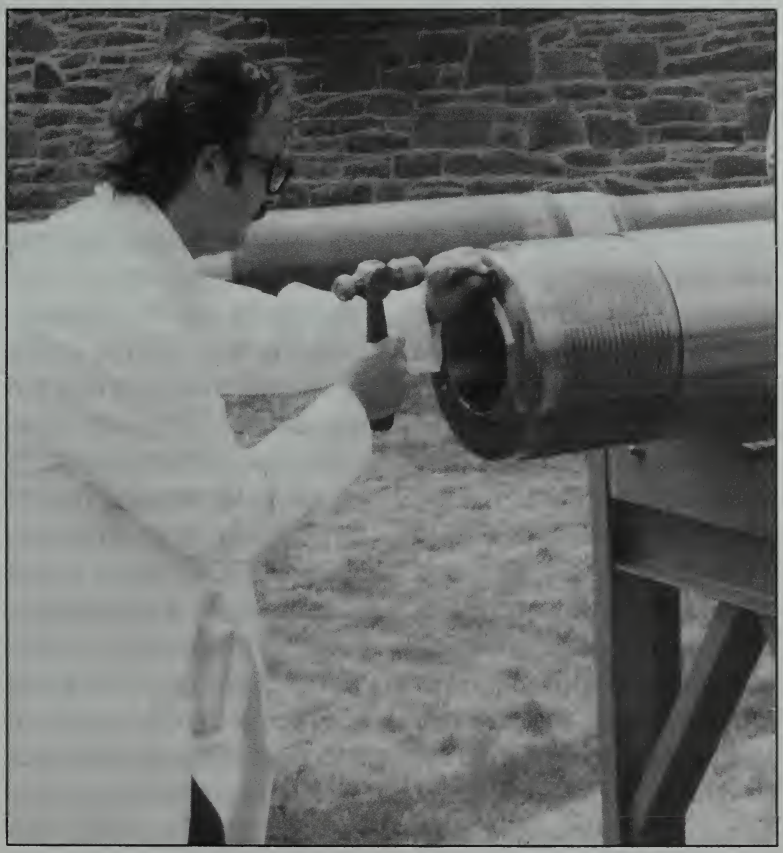
The First Army Band performed in concert on the grounds. The historic drill team, the Old Guard, was at its best. Joining in were the Artillery Co. of Newport; the 1/7th Field Artillery; and the Order of the Mountain Eagle. There was a Civil War encampment, antique fire trucks and, one of the biggest attractions of the day, an army obstacle course for kids to earn fitness certificates.

By late afternoon, the crowd moved out the main gates to the north of the arsenal where the city hosted a street festival with ethnic foods, entertainment and, what many described as, the best fireworks display in decades. And this was only Day One!

Sunday was sports day. Golf, softball, horseshoes and

tennis were the four categories contested. Following the competitions, an awards bash was held and the winners received trophies and their names were engraved on the Colonel's Cup plaque (still on display in the foyer of the Headquarters Building.)

Monday and Tuesday were working days but the gala continued with VIP tours by invitation and a seminar on "Military Research and Its Impact on Private Industry," attended by business and community leaders. Tuesday night was Arsenal Night at Heritage Park, the local minor league baseball park.



STAMPING — The initials of the new commander are stamped into the first gun produced under his command.

Several hundred arsenalites turned out to wear their special caps and root for the Albany-Colonie Yankees.

On Wednesday, an appreciation luncheon was held to thank all the volunteers and sponsors who worked so hard to make the week a success.

Thursday was Reaffirmation Day with city Mayor J. Leo O'Brien and the new commanding officer Col. Joseph H. Mayton signing a document reaffirming the spirit of cooperation between the arsenal and the city. As part of the ceremony, there was an historical reenactment of the signing of the deed which had transferred the original 12 acres of arsenal land from the Gibbons family to the U. S. Government. Mr. Tom Kucskar, retired chief of manufacturing, and his wife were dressed in period costume, portraying Mr. and Mrs. Gibbons.

Yes, in the midst of all the hoopla, the arsenal did find time to hold another change of command ceremony. Col. Walker welcomed Col. Mayton and, in addition to the passing of the flag of command, a new tradition was begun. It is a long ordnance tradition that the initials of the commanding officer be stamped on each cannon produced under his command. This derives from a time when the colonel was, literally, personally responsible for each item.

Two 120mm cannon were set up on stands and Col. Walker's initials were stamped into the last gun made under his command while Col. Mayton's "JHM" was stamped into the first gun under his watch. The pinging of the dies against the alloy steel rang out across the parade field. It was too nice a touch to do only once. It has been part of each change of command ceremony since.

The grand formal ball was held on Friday night at the Empire State Plaza in Albany with Speaker of the House Jim Wright as guest speaker and Congressman Stratton doing the introductions. Arsenalites in black tie and formal gowns filled the large plaza ballroom, enjoying good food and dancing to

the nostalgic big band sounds of the Glenn Miller Orchestra.

The grand week ended with a joint arsenal-city employee Family Day picnic on the arsenal. There was a relaxed "We did it!" air. The only formal program of the day was the sealing of the time capsule in the cornerstone of the north wing of Building 35. Throughout the week, employees were asked to sign a scroll. The scroll was among a number of items selected to be sealed up in the cornerstone, including 175th Birthday memorabilia and a videotape of the arsenal of 1988.

The next Monday it was back to business for the new commander. Col. Mayton, the 47th man to head the arsenal, came to Watervliet from AMC headquarters where he served as chief of Support System Division, Development, Engineering and Acquisition Directorate. Col. Mayton also brought the lively sounds of young children back to Quarters One when he and his wife, Sally, introduced sons Joseph III and Mark to the arsenal community.

Col. Mayton assumed command of the arsenal in the midst of a long-range belt-tightening. The official word from AMCCOM had come a couple months earlier. In effect, it echoed that old New England maxim: "Use it up, wear it out, make do, or do without."

Another command change took place late in 1988. Tom Fitzpatrick, who had been serving as Operations director, was named the arsenal's first-ever Civilian Executive Assistant. The new position replaced the military deputy commander's position which in recent years had been filled by a lieutenant colonel. The reduction in military slots was further evidence of the cutbacks and belt-tightening. Fitzpatrick, who had started as an apprentice more than 25 years before, had risen steadily through the managements ranks. He knew the arsenal inside and out and was well-suited to the new role as civilian "second in command."

But with all of the cel-

ebrating and staff changes, work went on. A new Computer Integrated Manufacturing (CIM) Technology Lab opened. Employees could be trained on miniature (but accurate) computer-controlled machine tools. This was one of the most comprehensive CIM Tech training labs anywhere, public or private sectors.

December 1988 marked the public unveiling of an experimental new gun, the product of close cooperation between Watervliet Arsenal and Benet Laboratories. Called the electromagnetic rail gun, the device used electromagnetic force to propel a projectile at superspeeds. One of the more remarkable developments in arsenal history, it held promise of being the heavy weapon of the future.

In previous peacetime ebbs in production, the arsenal had "gone on the road" looking for non-mission items to manufacture. The arsenal had produced marine drive shafts, collapsible bridges for fording streams and bomb racks. But 1989 saw the arsenal produce one of the most interesting non-mission items, the MicLic—Mark 155 Mod 0 Mine Clearance System, Trailer Mounted.

A device employing explosives strung together in something like a firehouse, the MicLic was used to clear enemy mine fields. The arsenal was manufacturing the frame and rail system which held the tube in which the hose was placed.

The object was to fire this long hose-like series of charges out into a mine field. The hose spread out and the charges went off, in turn setting off any enemy mines. In just a few short years, during the War in the Desert, the MicLic would be put to good use.

Each commander attempts to set some long range goals for the arsenal while trying to stomp out the day to day fires. For Col. Mayton, Total Quality Management was his legacy. It wasn't that TQM had originated under Col. Mayton but he was dead set on seeing that TQM systems be institutionalized at

the arsenal.

In an article written by him for the post newspaper, Col. Mayton began: "Watervliet Arsenal has embarked on a high pay-off initiative called Total Quality Management which focuses on continuous process improvement, customer satisfaction, and the creation of value at each level of the organization."

Col. Mayton set up cross-functional teams to work on systemic problems. And, knowing that most people resist change, he insisted the investment in TQM be such that it would become part and parcel of everyday life at Watervliet. "TQM," he said, "will involve every member of the arsenal — both manufacturing and administrative; logistical, engineering and support personnel as well as contractors and our vendor base."

Executive and middle management training sessions were held in April, August and October of 1989. The University at Tennessee Management Development Center conducted the training and helped the arsenal focus on three major systems. The three systems — equipping, acquiring, and designing, were complex and dynamic. Teams of about 10 top level managers were assigned to each. The work of these teams continued into the '90s.

Arsenal personnel continued to shine even in tough times. Charles Cornwell, chief of the Apprentice Training Branch, was named one of the Top 10 Outstanding Army Materiel Command Personnel of the Year. And Glenn Friar, chief of Benet's Advanced Technology Branch, was one of 10 federal employees worldwide named to receive the Presidential Disabled Federal Employee of the Year Award. Paralyzed from the waist down in a rock climb, Glenn continued his arsenal career as a caring manager as well as a tireless advocate for a "barrier free" environment.

On the technical side of the house, the EX35, low recoil 105mm gun attracted international media attention with a featured article in In-

ternational Defense Review. Designed, constructed and test-fired in 11 months, the magazine said the feat would not have been possible if not for the co-location and close cooperation of the arsenal and Benet.

One of the most interesting devices ever made at the arsenal made its debut late in 1989. Benet's motion simulator, looking something like a Star Wars movie prop, enabled researchers to simulate the yaw, pitch and roll of a real tank or other vehicle as it races over rough terrain. Developed for the autoloader program, the simulator, according to its developers, could be used for a wide variety of applications. Vehicles can be tested over simulated terrains while saving the expense of actually having to drive over proving ground courses. The environment is more controllable and testing cheaper.

The '90s at Watervliet Arsenal began on a high note. The arsenal won the Second Annual World Class Manufacturing Award. The award, indeed of world class stature, was presented to the arsenal for its strategic planning for automation. David Callahan, director of Advanced Technology and Systems, whose group prepared the submission, joined the commander and other top managers in accepting the award in Chicago.

By March, however, the mood was more somber. Rumors abounded about layoffs and workload. Secretary of Defense Dick Cheney had ordered a 12 percent cut in his office staff. By 1995, he said, *defense spending would be at its lowest percentage of federal spending since before World War II.*

"Such a significant spending reduction cannot occur," he said, "without reducing the number of DoD people, both military and civilian."

And in May, the "R" word was reality. It appeared that a reduction-in-force (RIF) would be necessary for the arsenal to deal with cuts in funding and production. The post newspaper, Salvo, offered a three-page article on just what a RIF is, how posi-

tions are selected for elimination and what individuals can do in the way of "bumping" to another job or getting help with employment outside the arsenal.

Such was the environment in which Col. Michael J. Neuman became the 48th arsenal commander. A graduate of West Point, Col. Neuman came to Watervliet from an assignment as a member of the faculty at the Naval War College, Newport, R. I. Prior to that, he had served for five years on the Abrams Tank Program, which included a tour as commander of the Detroit Tank Plant.

Col. Neuman's calm demeanor, quick humor and keen insight was just what was needed. He quickly organized a series of talks with employee groups — reaching every employee. He told them what he knew about the funding and employment environment and assured them he would do everything he could to minimize the impact on employees. Feedback from the meetings said the workforce believed he would do just that.

It was inevitable. On Thursday, Aug. 30, RIF notices were delivered to 361 employees. Of these 361, 218 were notified that they would be losing their jobs. Forty received reassignments to new positions and 103 were told they would be shifted to jobs in lower pay grades.

Each person notified was scheduled for a one-hour, one-on-one session with a personnel specialist to hear of their options.

The notices were to take effect on Friday, Nov. 2, 1990. In the meantime, the arsenal had been granted voluntary early retirement approval which, it was hoped, would lessen somewhat the burden on those receiving RIF notices. The window for early retirement was open until Sept. 15.

But even in times of a RIF life goes on. One amazing diversion occurred in September and involved a small balloon. One day a small white balloon, inflated by Jason Gilmor of Eureka, Mo., Elementary School, was sent aloft along with 400 others. The balloons were part

BUNKER BUSTER — Sen. Alfonse D'Amato inspects "bunker buster" with Col. Neuman and Tom Fitzpatrick.

of a project by the Missouri school. Jason's balloon, braving the stiff, frigid winds of high altitudes, traveled 1,200 miles and landed smack in the middle of Watervliet Arsenal. Arsenal attorney Bob Blackwood discovered the balloon and gave it to Public Affairs Officer John Swantek. A few calls later and an amazed fourth grade

teacher was on the line. The arsenal sent Jason a history book and the school sent the arsenal its Eureka Country Cookbook. It was a diversion that said 'anything is possible.'

Iraq's Saddam Hussein crossed the border into Kuwait and, suddenly, the world changed. By September 1990, it was clear that Col. Neuman had an important decision to make. Should he release valued, experienced employees to meet what was the known decrease in workload? Or should he keep these employees on in anticipation of a need should Operation Desert Shield require the arsenal to quickly gear up?

In the end, in his quiet, deliberative manner, Col. Neuman decided he could not afford to risk losing needed talent when the world situation was heating up. Once again the ebbs and flows of the arsenal's history came back to the need for a strong productive arsenal in times of conflict. The RIF, in general, was canceled. Only a handful of positions were actually eliminated. The majority of the 218 people who were to lose their jobs stayed on.

It was a good decision.

In January of 1991, Operation Desert Shield became Operation Desert Storm. World forces, led by the United States, stormed into the region to free Kuwait. The 120mm gun on the M1A1 Abrams Tank was a huge success as were the arsenal's 155mm howitzers for the towed and self-propelled artillery. The MicLic was pressed into service, especially along the heavily mined Kuwait-Iraq border. Cable News Network, broadcasting live (at times from within Iraq itself) aired views of the mine clearer in action, destroying heavily-mined roads and passages, saving coalition lives.

A wartime spirit prevailed. Operation Yellow Ribbon was launched with dozens of yellow ribbons being tied to arsenal trees awaiting the safe return of our armed forces. Community groups collected boxes of those little sundry items

that make life at the front more bearable: razors, eye drops, hand cream, nail clippers, peanut butter, etc.

More than 60 items produced at the arsenal were used in the Gulf War at its peak. Unknown at the time to most, and especially to the majority of arsenal employees, was one prominent arsenal product which would help end the war. The Bunker Buster.

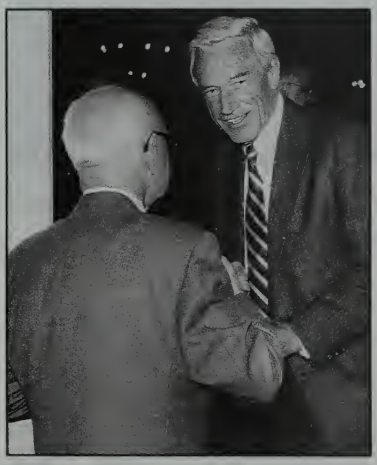
On Friday, Jan. 25, 1991, Gerry Yarter, chief, Production Planning and Control Division, Operations Directorate, received a telephone call from Lockheed Missile and Space Co., San Jose, Calif. They were looking for something to use in the manufacture of a 5,000-pound bomb to be used on the deep bunkers of Saddam Hussein. The 2,000-pounders being used were doing little more than bouncing off the thick concrete bunkers in which Saddam's leaders were entrenched.

With little to go, Yarter assembled a team. Operating in strict secrecy, the group went to work, working around the clock, working weekends. They had determined that 8-inch M201s could be used to configure the body of the bombs. A couple were on hand at Watervliet already.

The project was a harbinger of how modern warfare would be conducted. Fax machines hummed. Yarter's team would cut metal within minutes of receiving the latest engineering specs. The number crunching was instantaneous. There was continuous recalculating. It became a consortium effort among the arsenal, Lockheed, Wright Labs at Eglin Air Force Base. The arsenal was the manufacturer. Cameron Iron Works in Houston provide the nose.

The first two "bunker busters," officially known as the GBU-28 Hard Target Penetrator, were delivered on Sunday, Feb. 17. Yarter had made arrangement with the Air National Guard at Stratton Air Base, Schenectady, to take the two units to a test site. The first was dropped from an F-111 and struck the test area on target. Without explosives, the unit plunged more than 100 feet into the

HONORING SAM — Brian Stratton, son of the late Rep. Sam Stratton, accepts plaque from Col. Bernard P. Thomas.



SAM — Sam Stratton chats with arsenalite during one of many visits.

ground, deeper than special earth-moving equipment could dig to retrieve it.

In a second test, the hard target penetrator was mounted on a rocket sled for horizontal testing, again, without explosives. In dramatic videotaped footage of the test, the unit is seen slicing through 22 feet of solid concrete and continuing on downrange for more than half a mile before hitting the

NEW SHOPS — REARM was over and arsenal shops were state-of-the-art and ready for the new century.

ground and beginning to tumble.

The "bunker busters" appeared as if they would do the job.

Two other units were loaded with explosives and sent to the war in the desert. According to Gen. Ronald W. Yates, commander of the Air Force Systems Command, the GBU-28s were used against only one target in Iraq. He described the

target as a command and control complex containing senior staff of the Iraqi military.

These two were dropped on the bunker on Feb. 27, barely one month after the initial phone call.

It is significant to note that Saddam Hussein agreed to a cease fire the very next day.

It was another chapter in the arsenal's long history of coming through in the crunch; of being there and being ready when needed.

For his efforts, and the efforts of his team, Yarter was named in 1992 as one of the "Ten Outstanding AMC Personnel of the Year."

But the quick war in the desert produced only a relative blip in arsenal workload. Once again, Watervliet faced the start of a new year with some concern about workload and workforce stability. Thanks to arsenal management, employment figures were reduced without the need for a RIF. A self-imposed hiring freeze, allowed the arsenal to "downsize" through attrition alone.

The workforce in late 1992 totaled just over 2,000, including all tenants. This was down from 3,200 just 10 years before but at least the reduction had ben accomplished without a major RIF.

This "downsizing" or, as some called it, "rightsizing" environment was what greeted the arsenal's new commander, Col. Bernard P. Thomas.

Col. Neuman had received a call to a new job at the Pentagon and the change of command ceremony developed quickly. Col. Thomas, in fact, still had business to clear up at the Army Ordnance Missile and Munitions Center and School, Redstone Arsenal, Ala., and some training to complete.

A graduate of Pennsylvania State University with bachelor's and master's degrees in education, he brought to the arsenal extensive experience in ordnance management, including an assignment as commander of Pueblo Army Depot, Colorado.

With patience and a keen attention to detail, Col. Thomas set about tackling the

systemic problem areas of the arsenal, such as the utilities infrastructure, quality of life, etc.

As the arsenal's 180th year began, Col. Thomas began to hit his stride reemphasizing Total Quality Management and asking the tough questions about what was needed to bring the arsenal's infrastructure in line with the modernization that had taken place within the manufacturing realm.

This was a vital period in the life of Watervliet Arsenal; a time of flux. The nation had elected a Democratic President for the first time in 12 years and President Clinton promised change. It seemed clear that this change would involve an ever-shrinking defense budget. This was a time of great challenges and great potential.

On June 19, 1992, Building 20 was dedicated in honor of the late Rep. Samuel S. Stratton, who had passed away two years before. A tireless supporter of Watervliet Arsenal, the congressman was often referred to as the arsenal's own "Uncle Sam."

This ceremony also marked the completion of REARM. The $306.2-million renovation of the arsenal had begun in 1979 and continued for 13 years. There were many disruptions, numerous frustrations and challenges. But, in the end, the new arsenal was impressive with its modern machine tools and efficient layout.

In all, more than 186,000 square feet of production space had been added at a cost of $31.3 million. The arsenal had purchased 342 new machine tools and rebuilt 100 others at a cost of $234.9 million. More than $40 million was spent of plant rearrangement and project engineering. Before REARM, the arsenal had grown in fits and starts over the decades. An outside diameter might be turned in Building 135 but the tube might have to be carted to several other sites for other steps in manufacturing. One of the main goals of REARM was to establish to smooth, efficient — and logical — flow of work through the arsenal,

saving the time and money of unnecessarily hauling work among buildings.

The challenge now was to keep this investment working; to keep the arsenal strong and vibrant.

The arsenal was beginning to feel its way into a new image — a leaner more flexible armament manufacturing facility.

Employment early in 1993 was hovering around the 2,000 mark for the arsenal and all tenants, down from the nearly 3,500 of only a dozen years before. The possibility of a RIF was surfacing again although by February of 1993 it appeared that the arsenal and Benet had proved their workload supported the current employment numbers. President Clinton was announcing plans for even greater cuts in the defense budget. Even more belt-tightening would be in order. The arsenal, however, was not sitting around on its hands waiting to shrink. Arsenal management had decided to get out on the road and take their future into their own hands as much as possible.

Gerry Yarter, the "bunker buster" becoming a memory, was named to head up a new office at the arsenal, the Customer Program Development and Service Office. The new organization was created to formalize the arsenal's marketing efforts and to make customer service a number one priority. Yarter's organization is busy exploring new products, mission and non-mission. Making use of new legislation, sponsored by Rep. Michael McNulty, the arsenal began a program of aggressively seeking out workload to position itself for the coming of the century, the new millenia.

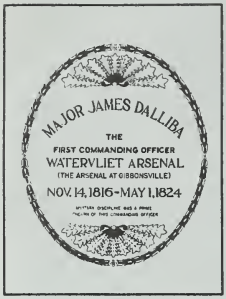
A NEW ARSENAL — The $306.2-million REARM project had changed the face of the arsenal. In this aerial view, looking west, the new red brick facade of the additions to Building 35 standout against the darker, weathered brick of the Big Gun Shop.

Appendix One
List of Commanding Officers

	From	To
James Dalliba, Major	Nov. 14, 1816	May 1, 1824
George Talcott, Lt. Col.	Sept. 21, 1824	Jan. 25, 1835
William J. Worth, Lt. Col.	Jan. 26, 1835	April 30, 1838
Rufus L. Baker, Lt. Col.	Oct. 10, 1838	Oct. 10, 1851
John Symington, Major	Oct. 10, 1851	June 23, 1857
Alfred Mordecai, Major	June 23, 1857	May 14, 1861
William A. Thornton, Col.	May 15, 1861	Dec. 25, 1863
Peter V. Hagner, Brig. Gen.	Dec. 25, 1863	Dec. 3, 1880
Adelbert R. Buffington, Lt. Col.	Dec. 3, 1880	Nov. 2, 1881
Alfred Mordecai, Jr., Lt. Col.	Nov. 2, 1881	May 12, 1886
James M. Whittemore, Col.	June 5, 1886	Nov. 11, 1889
Francis H. Parker, Lt. Col.	Nov. 21, 1889	Dec. 12, 1892
Isaac Arnold, Lt. Col.	Dec. 19, 1892	Feb. 14, 1898
Alfred Mordecai, Jr., Col.	Feb. 23, 1898	May 8, 1899
Joseph P. Farley, Col.	May 26, 1899	Feb. 17, 1903
Charles Shaler, Lt. Col.	Feb. 18, 1903	July 13, 1903
Daniel M. Taylor, Lt. Col.	July 14, 1903	March 31, 1905
Ira MacNutt, Lt. Col.	May 1, 1905	Jan. 7, 1908
William W. Gibson, Col.	Jan. 20, 1908	Feb. 17, 1918
John E. Munroe, Col.	March 1, 1918	Sept. 3, 1918
Charles G. Mettler, Col.	Sept. 3, 1918	March 10, 1919
J. Walker Benet, Col.	March 11, 1919	May 28, 1921
William I. Westervelt, Lt. Col.	May 31, 1921	Sept. 1, 1923
Edwin D. Bricker, Col.	Oct. 1, 1923	July 30, 1929
Herman W. Schull, Col.	Sept. 9, 1929	Feb. 27, 1932
Charles A. Schimelfenig, Maj.	Feb. 28, 1932	July 31, 1932
Gilbert H. Stewart, Col.	Aug. 1, 1932	Sept. 12, 1938
Richard H. Somers, Col.	Nov. 14, 1938	July 17, 1940
Alexander G. Gillespie, Brig. Gen.	July 19, 1940	March 31, 1945
Clarence E. Patridge, Col.	April 1, 1945	April 30, 1946
John C. Raaen, Col.	May 1, 1946	Sept. 2, 1947
Harry N. Rising, Col.	Sept. 4, 1947	Aug. 15, 1952
Richard Z. Crane, Col.	Sept. 1, 1952	Aug. 31, 1954
Elmo S. Mathews, Col.	Sept. 20, 1954	June 30, 1958
Walter M. Tisdale, Col.	Aug. 13, 1958	Jan. 31, 1962
Keith T. O'Keefe, Col.	Feb. 1, 1962	July 31, 1965
Fred Kornet, Jr., Col.	Aug. 1, 1965	Sept. 14, 1967
Arthur H. Sweeney, Jr., Col.	Nov. 1, 1967	Aug. 19, 1968
William Mulheron Jr., Col.	Dec. 20, 1968	June 30, 1971
Christopher S. Maggio, Col.	July 15, 1971	Aug. 31, 1973
Richard H. Sawyer, Col.	Sept. 9, 1973	July 24, 1975
Malcolm V. Meekison, Col.	July 25, 1975	Aug. 29, 1976
Church M. Matthews Jr., Col.	Sept. 21, 1976	Sept. 8, 1978
Robert W. Pointer, Jr., Col.	Sept. 8, 1978	July 14, 1980
Gerald R. Wetzel, Col.	July 14, 1980	July 19, 1983
Edward V. Karl, Col.	July 19, 1983	Jan. 22, 1986
Robert T. Walker, Col.	Jan. 22, 1986	July 14, 1988
Joseph H. Mayton, Jr., Col.	July 14, 1988	July 19, 1990
Michael J. Neuman, Col.	July 19, 1990	March 20, 1992
Bernard P. Thomas, Col.	March 20, 1992	—

(Rank shown is highest rank while commander.)

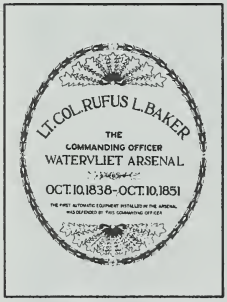
Appendix Two



Maj. James Dalliba

Lt. Col. George Talcott

Lt. Col. William J. Worth



Lt. Col. Rufus L. Baker

Maj. John Symington

Maj. Alfred Mordecai

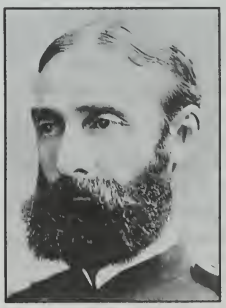
Col. William A. Thornton

Brig. Gen. Peter V. Hagner

Lt. Col. A. R. Buffington

Col. Alfred Mordecai, Jr.

Col. James M. Whittemore

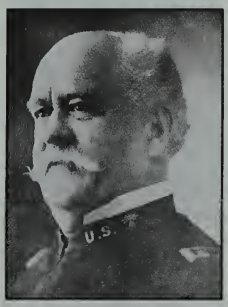


Lt. Col. Francis H. Parker

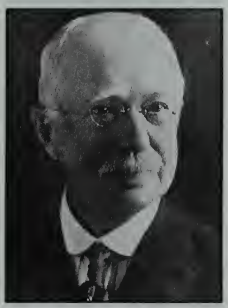
Lt. Col. Isaac Arnold

Col. Joseph P. Farley

Lt. Col. Charles Shaler



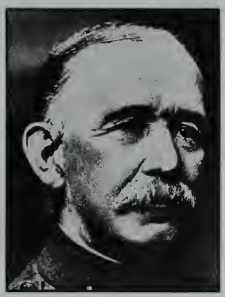
Lt. Col. Daniel M. Taylor


Lt. Col. Ira MacNutt

Col. William W. Gibson

Col. John E. Munroe

Col. Charles G. Mettler


Col. J. Walker Benet

Lt. Col. William I. Westervelt

Col. Edwin D. Bricker

Col. Herman W. Schull

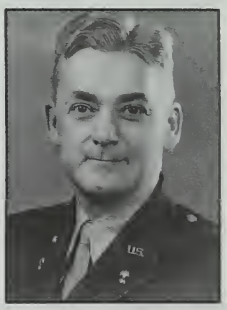
Maj. Charles A. Schimelfenig

Col. Gilbert H. Stewart

Col. Richard H. Somers

Brig. Gen. A. G. Gillespie

Col. Clarence E. Partridge

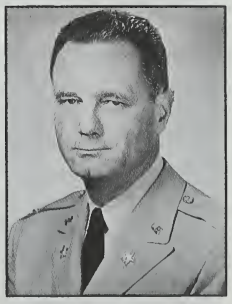

Col. John C. Raaen

Col. Harry N. Rising

Col. Richard Z. Crane

Col. Elmo S. Mathews

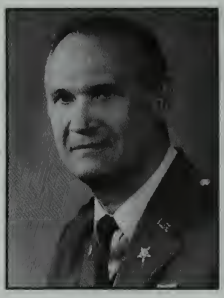
Col. Walter M. Tisdale


Col. Keith T. O'Keefe

Col. Fred Kornet, Jr.

Col. Arthur H. Sweeney, Jr.

Col. William Mulheron, Jr.



Col. Christopher S. Maggio

Col. Richard H. Sawyer

Col. Malcolm V. Meekison

Col. Church M. Matthews, Jr.

Col. Robert W. Pointer, Jr.

Col. Gerald R. Wetzel

Col. Edward V. Karl

Col. Robert T. Walker

Col. Joseph H. Mayton, Jr.

Col. Michael J. Neuman

Col. Bernard P. Thomas

Appendix Three

Annual Reports of Watervliet Arsenal, 1900-1942

Semi-Annual Historical Reports of Watervliet Arsenal, 1946-1950

Annual Historical Summaries of Watervliet Arsenal, FY63 to 92

"History of Watervliet Arsenal, 1813-1920," by Francis K. Kyle

"History of the Watervliet Arsenal, 1813-1946"

Letter Books, 1813-1900, Official Letters of Commanding Officers

Memoranda of Watervliet Arsenal Operating Officials, 1950-1979

Memorandum of January 1968, Capt. J. M. White, AGC, Post Adjutant

Monthly Reports, July 1940 to March 1945, Brig. Gen. A. G. Gillespie

Monthly Reports, April 1945 to April 1946, Colonel C. E. Partridge

Monthly Reports May 1946 to June 1946, Colonel J. C. Raaen

Watervliet Arsenal Order Book, 1813-1820

Ordnance Reports by Office of Chief of Ordnance, 1812-1900

Watervliet Arsenal Scrapbooks, 1946-1979

Command Operating Program Progress Reports, Fiscal Year 1964.

Salvo, Watervliet Arsenal monthly in-house publication, 1979-1993

Watervliet Arsenal Public Affairs Office Newsclipping Files

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1813~1993 THE WATERVLIET ARSENAL

A complete historical account of the Arsenal from its role in the War of 1812, through its commissioning as producer of "...heavy ordnance adapted to modern warfare, for the use of the Army and Navy of the United States," and as the continuing leader of today's most challenging manufacturing and technological endeavors.

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1813